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Cover Photograph: Australian Gannets, *Lawrence Rocks* taken by J. Cooper, Fisheries and Wildlife Division, Ministry of Conservation

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Erratum: No. 41, Article 1. Coauthor's name should read G. M. Philip.

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HOLOCENE FORAMINIFERIDA FROM THE FITZROY RIVER ESTUARY, NORTH WEST AUSTRALIA

By A. C. Collins

Honorary Associate in Palaeontology, National Museum of Victoria.

Abstract

Six species are recorded or described. One of these *Siphotrochammina* aff. *lobata* does not appear to have been previously recorded from Australian waters, another *Nubeculopsis queenslandica* is discussed in terms of its validity as a species and genus, and the remaining four are described as new. Of these, three have morphological features which appear to justify the erection of new genera. They are *Munkiella* (*M. lingulata*), *Bisaccoides* (*B. cuspidatus*) and *Delosinella* (*D. planispiralis*). Specimens were obtained from a shallow borehole in a mangrove flat, and there is no evidence of their existence in the local living fauna, though this appears probable.

Material

The foraminiferida described herein derive from a shallow core (maximum depth 280 cm) taken in the course of geomorphological investigations by Dr J. N. Jennings of the Research School of Pacific Studies, Australian National University. The samples listed were, amongst others, entrusted to the author some years ago for examination of their fossil content for any light it might throw on the matter of marine transgression in the area. However, apart from this core (site distinguished as Munkayarra H. 12), only very sparse assemblages of foraminiferids were found, up to a maximum of 17 specimens per sample, and in most cases less or nil.

The location of the core was at grid reference 189003 on 1:50000 R.A.S.C. sheet 3663-III, Derby, Lat. 17°28′ S., Long. 123°35′ E. It was drilled in low mangrove scrub (*Avicennia marina*), but the area is one of extremely fast lateral erosion by the main estuarine currents, and it is probable that the sediments concerned have long since been removed in this manner (Jennings, *pers. comm.*)

Four samples were taken from the core, as described hereunder:

275-280 cm. Silt with a few small clay lumps. Residue after washing through a 180-mesh sieve was almost entirely marine skeletal material, including pteropod and other molluscan shells, ostracods, sponge spicules in profusion, alcyonarian spicules and foraminiferids, with mica flakes and a few small angular sand-grains. Approximately 150 species of foraminiferids were found, mostly smaller benthic species with a few pelagic forms and the juvenile tests or small fragments of the commoner larger species. The general even size of specimens suggests that the assemblage is a current-sorted thanatocoenosis having little relation to the living local population at the time of deposition.

195-200 cm. Generally similar to the above, but with a more diverse foraminiferid assemblage of ca. 200 species.

85-90 cm. Similar to the foregoing samples but containing a proportion of woody fibre and having a smaller assemblage of ca. 110 species.

0-5 cm. Quite different to the deeper samples, containing much fibrous material and a small assemblage (ca. 20 species) of foraminiferids, dominated by the agglutinated genera *Trochammina* and *Siphotrochammina*. Small hollow agglutinated tests with a pink shining chitinoid lining were also present, and in the lack of expert opinion were provisionally considered to be Thecamoebidae.

Very little can be deduced from these widely-spaced samples, other than an increasing freshwater influence in the later stages of deposition. The Fitzroy estuary alternates between a short phase when fresh water dominates and a long phase when salinities are very high and marine influence dominates. (Jennings, *pers. comm.*). Reworking is probably common, as noted earlier. The assem-

blages found consist in the main of well-known Indo-Pacific shallow-water species, and the interest of the samples lies in the occurrence of comparatively few forms which are either undescribed or of interest in terms of distribution or morphology. These are dealt with in the following systematic account. It is unfortunate that the remoteness of the locality has precluded further collection and preservation of fresh bottom samples, so that the presence of these species in the living state cannot as yet be established.

Systematic Account

Family TROCHAMMINIDAE Schwager 1877
Genus **Siphotrochammina** Saunders 1957

Type species: Siphotrochammina lobata Saunders 1957, Holocene, Trinidad, West Indies.

Siphotrochammina aff. lobata Saunders, 1957
(Plate 2, fig. 1)

This species is noted because the genus does not appear to have hitherto been recorded from Australia. It was described from brackish-water deposits in the West Indies and apparently has similar habitat preferences locally. It occurs in numbers only in the 0-5 cm sample which shows freshwater influence in the sharp reduction in foraminiferid species and by the presence, as noted above, of an organism which may be a thecamoebid and which occurred in other bore samples showing little or no marine influence.

Though direct comparison with the type was not practicable, specimens closely resembled that figured by Saunders, having the siphon-like umbilical extension of the chamber and the distally-facing aperture, also the tendency to irregularity in the chamber shape. Coiling direction is random, about half the specimens being either right- or left-handed.

The occurrence of this brackish-water species in such widely-separated localities is not easily explained, as it is apparently restricted to the Holocene. It may be a case of convergent evolution from some cosmopolitan species in the particular environment of tropical brackish water. However, the morphological similarity of the present form to *S. lobata* requires it to be recorded as close to or identical with that species.

Family NUBECULARIIDAE Jones 1875
Sub-family NUBECULARIINAE Jones 1875
Genus **Nubeculopsis** Collins 1958

Type species: Nubeculopsis queenslandica Collins 1958, Holocene, Great Barrier Reef.

Nubeculopsis queenslandica Collins 1958

This species was described from the Great Barrier Reef and was distinguished from *Nubecularia* by the loss of the cornuspirine coil which follows the proloculus in that genus. Arnold (1967) has described the high degree of variation encountered in artificially cultured progeny of *Nubecularia lucifuga* Defrance and has expressed the opinion (*pers. comm.*) that *Nubeculopsis* falls within the range of variation of both natural and cultured populations of *N. lucifuga* from the Mediterranean.

Nubeculopsis occurs in the present material, and specimens are similar to those from the Queensland coast. While they are very variable in form, depending largely on the surface to which they were attached, they are consistent with the characteristics of the genus as described. No specimens referable to *N. lucifuga* were found, nor was this species recorded in the work in which *Nubeculopsis* was erected.

The writer has never found specimens referable to *Nubeculopsis* in the cool water deposits of the southern coast of Australia, where *N. lucifuga* is common and typical. Recent literature on foraminiferida of the central New South Wales coast (Alberti 1968a, 1968b, 1970, 1978) does not mention either genus, and Dr Alberti has informed me that he has not as yet found either form in N.S.W. waters. It may be that intermediate forms exist on the western coast of Australia, but until such evidence is found it is a reasonable assumption that the geographical ranges of the two taxa are mutually exclusive, at least in the Australian context.

It may be arguable whether the loss of the coiled part of the juvenile development justifies the erection of a separate genus, though this has been accepted at even higher taxonomic levels in other families, e.g. *Textularia* and *Spiroplectammina*. However, until Australian natural populations are found to exhibit the high

degree of plasticity of form reported by Arnold, it would seem advisable to retain the present taxonomic distinctions.

Family ELPHIDIIDAE Galloway 1937
Sub-family ELPHIDIINAE Galloway 1937
Genus **Munkiella** gen nov.

Type species: Munkiella lingulata sp. nov.

Diagnosis: Test planispiral, semi-involute, chamber structure rotaliid with doubled septa and interseptal canals connected to a spiral canal between chamber base and the periphery of the previous whorl. A single row of pores follows the proximal edge of the sutures, generally masked by weakly-developed septal bridges with intervening cusps leading to pores. No external aperture; a primary areal foramen in the septal face of the last chamber is masked by a lingulate process arising from the periphery of the earlier whorl, passing up the face of the chamber and joining it in a depressed suture lined with irregular pores to form a chamberlet which communicates with the last chamber through the foramen and with the spiral canal below the chamber base. The chamberlet is resorbed in the construction of a new chamber and replaced by a rotaliid doubled septum. Wall hyaline-radiate, finely perforate.

The systematic position of this genus is somewhat doubtful. Its radial wall-structure, rotaliid chamber-form, sutural pores and rudimentary septal bridges suggest placement in the Elphidiinae, but the possession of an apertural chamberlet is a feature apparently not recorded for this sub-family. However, it could have evolved from a form such as *Cribroelphidium* by the development of a more complex apertural structure, and it is therefore placed tentatively in the Elphidiinae.

Munkiella lingulata sp. nov.
(Plate 1, figs. 1a, 1b, 1c. Plate 2, figs. 2a, 2b.

Description: Test planispiral with a tendency toward trochospiral growth shown by a slight obliquity of the final whorl in some specimens. Chambers rapidly increasing in height, 7 to 9 in the last whorl, periphery rounded and lobulate with a varying degree of angularity in the outline of later chambers. Sutures slightly depressed in the centre of the test, deepening to a cleft toward the periphery and then flattening out. A row of larger pores follows the proximal side of the suture, masked in larger specimens by an extension of the following chamber wall, forming weakly-developed septal bridges with intervening cusps leading to the pores, or obscured by their placement in the cleft formed by an inrolling of the edge of the previous chamber.

No external aperture is present, a primary areal foramen being masked by a lingulate process forming a chamberlet, arising from the periphery of the previous whorl, passing up the face and joined thereto in a depressed suture with no discernible apertural slit but lined with a row of irregular pores.

Chamber structure is rotaliid. During the formation of a new chamber the previous lingulate chamberlet is resorbed and replaced by a septal flap forming a double septum with interseptal canal to which pores apparently lead (though this was not clearly established by observation). The chamber base is saddle-shaped, arching clear of the previous whorl to form a spiral canal and curving upward to form the distal face, in which an arch-shaped areal foramen connects the chamber lumen with that of the apertural chamberlet, which in turn connects directly with the spiral canal and through this with interseptal canals (see text-figure 1). Chamber sides are produced toward the centre of the test to partly cover the earlier whorl, resulting in a nearly involute test.

Wall structure is hyaline-radial, finely perforate and semi-translucent, including the wall of the apertural chamberlet, which is therefore a true chamberlet and not a tooth-plate structure. Holotype from bore Munkayarra H. 12, 85-90 cm. Also found at 195-200 and 275-280 cm.

Dimensions of holotype: major diameter 0.54 mm, minor diameter 0.35 mm, thickness 0.18 mm.

Deposition of holotype: National Museum of Victoria, reg. no. P159780.

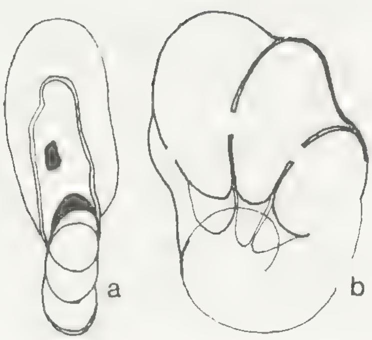

Fig. 1. *Munkiella lingulata* sp. nov.
(a) edge view with lingulate process removed, showing septal foramen.
(b) diagrammatic axial section.

Family CIBICIDIDAE Cushman 1927
Sub-family PLANULININAE Bermudez 1952
Genus **Bisaccioides** gen nov.

Type species: Bisaccioides cuspatus sp. nov.

Diagnosis: Test irregularly planispiral, umbilicus on both sides covered by a perforate and pustulose plate which extends as an inflated band over the depressed sutures from one side to the other, forming a continuous sutural canal which opens to the exterior by a series of cuspate arched openings on both sides of the sutural band. A similar but wider band covers the junction of the terminal chamber with the previous whorl, forming an apertural chamberlet masking a large basal aperture.

This genus has a morphological similarity to *Bisaccium* Andersen 1951 in possessing covered sutural spaces with accessory apertures, and in particular by having an extension covering the junction between the terminal chamber and the previous whorl so as to mask the aperture. However, *Bisaccium* is described as having a thin and finely perforate test wall, and by its classification in the Nonionidae is presumably granular in wall structure. The wall in *Bisaccioides* is comparatively thick, coarsely perforate, bilamellar and radial in structure, suggesting that its place is in the Cibicididae and because of its planispiral and non-adherent character, in the sub-family Planulininae.

Bisaccioides cuspatus sp. nov.
(Plate 1, figs. 2a, 2b, 2c. Plate 2, figs. 3a, 3b.)

Description: Test irregularly planispiral, chambers somewhat globose, up to 6 in the last whorl, periphery rounded and lobulate, biumbilicate. The umbilicus on both sides is covered by a perforate and pustulose plate which extends as an inflated band from one side to the other, covering the depressed sutures and forming a continuous sutural canal which opens to the exterior by a row of cuspate and arched openings on both sides of the band. A similar but wider band covers the junction of the terminal chamber with the periphery of the previous whorl, forming an apertural chamberlet which connects the enclosed umbilical space with the final chamber by a large arched basal aperture, and opens to the exterior by a similar double row of arched openings. When a new chamber is added, the part of the band within the chamber is resorbed, leaving the arched aperture as a septal foramen. Test wall is bilamellar, radial and coarsely perforate. Holotype from bore Munkayarra H. 12, 85-90 cm. Common at this sample, rare at 195-200 and 275-280 cm.

Dimensions of holotype: major diameter 0.5 mm, minor diameter 0.35 mm, thickness 0.21 mm.

Deposition of holotype: National Museum of Victoria, reg. no. P159781.

Family DELOSINIDAE Parr 1950 (emend.)

Diagnosis: Test triserial or planispiral, no primary aperture but large sutural pores open into subsutural canal.

Genus **Delosinella** gen. nov.

Type species: Delosinella planispiralis sp. nov.

Diagnosis: A delosinid in all respects except for the growth mode, which is planispiral rather than triserial.

Delosinella planispiralis sp. nov.
(Plate 1, figs. 3a, 3b. Plate 2, fig. 4.)

Description: Test ovate, chambers arranged in a planispiral coil and rapidly increasing in height, sutures slightly depressed and flanked on both sides by a row of large pores leading to

a subsutural canal, no primary aperture. Wall hyaline, translucent and finely pored. Holotype from bore Munkayarra H. 12, depth 195-200 cm. Only seven specimens were found, all consistent in form and differing only in size.

Dimensions of holotype: length 0.36 mm, width 0.22 mm, thickness 0.16 mm.

Deposition of holotype: National Museum of Victoria, reg no. P159782.

This species differs from the presently accepted definition of *Delosina* in having a planispiral growth mode rather than triserial, a difference which in the Nodosariacea is recognised at family level. However, in view of the small number of species involved, it appears more practical to erect a new genus within the family Delosinidae and to amend the family diagnosis to include planispiral forms.

Another delosinid occurred in rather greater numbers in the same material. These specimens were of triserial growth mode and had a row of pores along the sutures, more distinct in the small specimens than in the larger, together with a coarsely-pored area at the distal end. They appear to be referable to *D. polymorphinoides* Earland.

Family NONIONIDAE Schultze 1854
Sub-family NONIONINAE Schultze 1854
Genus **Nonionella** Cushman 1926

Type species: Nonionella miocenica Cushman 1926, Miocene, U.S.A.

Nonionella excavata sp. nov.
(Plate 1, figs. 4a, 4b, 4c. Plate 2, fig. 5.)

Diagnosis: A *Nonionella* with an excavated umbilicus partially infilled with spike-like processes.

Description: Test trochospiral, umbilicate, somewhat compressed with later chambers inflated, periphery rounded and slightly lobulate. All chambers visible on spiral side, only the last whorl of up to 10 chambers visible on umbilical side. Sutures slightly depressed and recurved, limbate on early chambers. On the umbilical side sutures end in a small radial fissure, and the inner end of each chamber is infolded radially for a short distance and attached to the floor of the chamber to form a division. The proximal part thus divided forms a lobate termination, the distal part forms an umbilical flap masking the narrow slit-like aperture and develops pointed protuberances which project into the umbilical cavity, those of earlier chambers appearing as clear granular nodules filling the centre of the umbilicus. The septal foramen is elliptical with a slight lip, near the base of the penultimate chamber. Wall structure is hyaline-granular, translucent and finely pored. Holotype from bore Munkayarra H. 12, depth 195-200 cm.

Dimensions of holotype: major diameter 0.63 mm, minor diameter 0.38 mm, thickness 0.21 mm.

Deposition of holotype: National Museum of Victoria, reg no. P159783.

Eleven specimens were found, nine coiled to the left when viewed from the umbilical side, two coiled to the right. One additional left-coiled specimen was found in beach sand from Doctor's Creek in the same general locality, suggesting its possible presence in the living state.

Acknowledgements

My thanks are due to Messrs. David Taylor and Ian Deighton of Paltech (Sydney), who have seen the manuscript and made helpful suggestions for its improvement, to Mr F. L. Walter and Mr H. B. Greenhill of Deakin University who made the S.E.M. photographs of Plate 2, and to C.S.I.R.O. Science and Industry Endowment Fund for the loan of equipment.

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Explanation of Plates

PLATE 1 (drawings)

Fig. 1. *Munkiella lingulata* sp. nov. Holotype. (a) and (b) side views, (c) apertural view. P159780.

Fig. 2. *Bisaccioides cuspatus* sp. nov. Holotype. (a) and (b) side views, (c) apertural view. P159781.

Fig. 3. *Delosinella planispiralis* sp. nov. Holotype. (a) side view, (b) edge view. P159782.

Fig. 4. *Nonionella excavata* sp. nov. Holotype. (a) umbilical side, (b) spiral side, (c) edge view. P159783.

PLATE 2 (S.E.M. photographs)

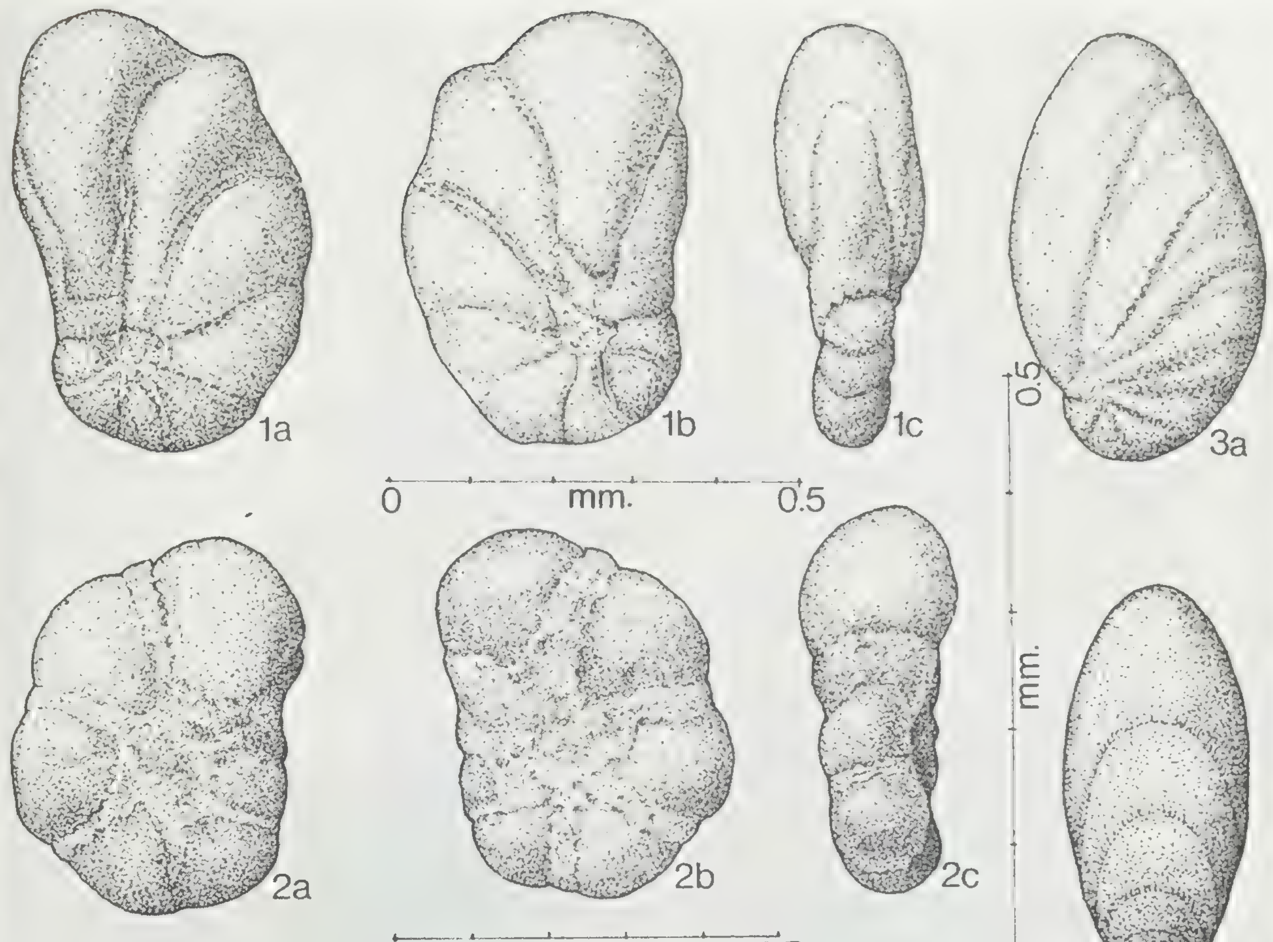
Fig. 1. *Siphotrochammia* aff. *lobata* Saunders, umbilical view x 206. P159784.

Fig. 2. *Munkiella lingulata* sp. nov. (a) side view, (b) apertural view. P159785.

Fig. 3. *Bisaccioides cuspatus* sp. nov. (a) side view x 140, (b) apertural view x 163. P159786.

Fig. 4. *Delosinella planispiralis* sp. nov. side view x 206. P159787.

Fig. 5. *Nonionella excavata* sp. nov. Umbilical view x 230. P159788.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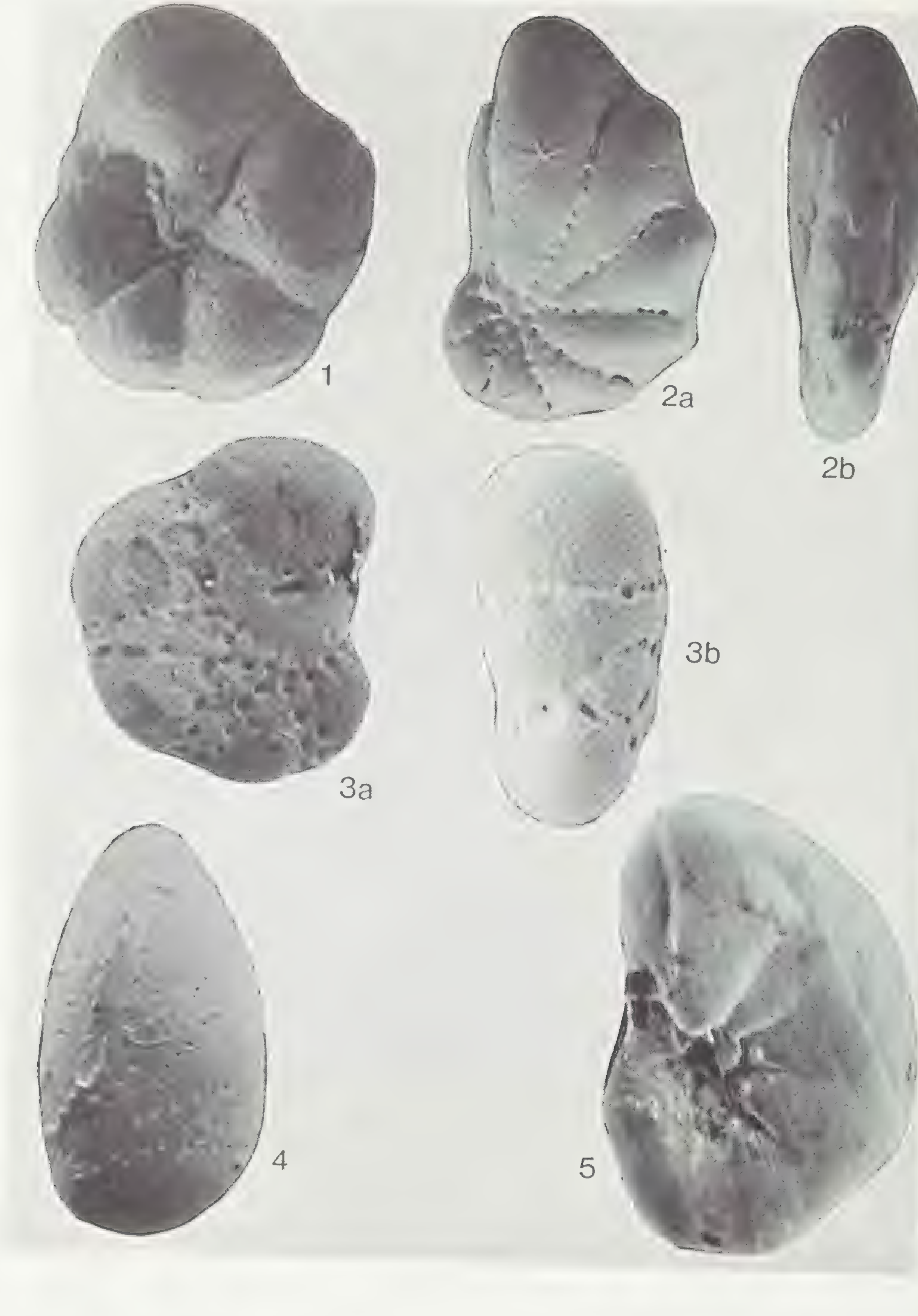
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A NEW SPECIES OF *TORNQUISTIA* (BRACHIOPODA: CHONETIDINA) FROM THE ARTINSKIAN (PERMIAN) OF WESTERN AUSTRALIA

By N. W. Archbold

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Abstract

The new species *Tornquista gregoryi*, from the late Baigendzinian (late Artinskian) Wandagee Formation of the Carnarvon Basin, Western Australia, is described. Internal structures of the species are elucidated by use of the peel technique. The content and evolution of the family Anopliidae is briefly reviewed and revised.

Introduction

The classification and distribution of the chonetacean family Anopliidae and representatives of the family from the Permian sequence of the Carnarvon Basin, Western Australia, have previously been investigated by the author (Archbold 1980). After that study had gone to press, Dr. P. Jell of the National Museum of Victoria passed on to me a collection of chonetid brachiopods, from the Permian sequences of Western Australia, that is housed in the National Museum collections. The specimens described below were collected by Dr C. Teichert in the years 1939 and 1941. The new species *Tornquistia gregoryi* was investigated with the aid of peels, a technique seldom applied to the Chonetidina as a group, and the value of this technique for the elucidation of hidden interior structures is shown herein.

Additions and amendments to the inferred phylogeny of the Anopliidae previously presented by the author (Archbold 1980, p. 182), made necessary by the works of Jing and Hu (1978) and Havlicek and Racheboeuf (1979) are given below.

Collections: All specimens are housed in the National Museum of Victoria (NMV), Melbourne, Victoria.

Stratigraphy and Age: Tornquistia gregoryi sp. nov. is known only from the Wandagee Formation of the Carnarvon Basin. The Permian stratigraphy of the Carnarvon Basin has been documented by Condon (1967) and reviewed by Playford et al. (1975); it is not proposed to review the sequence further here.

The age of the Wandagee Formation is considered to be Late Baigendzinian (Late Artinskian Stage) as indicated by Glenister and Furnish (1961), and revised by Dickins (1976) and Waterhouse (1976).

Localities for *Tornquistia gregoryi* sp. nov. are given with the systematic description.

Terminology: The terminology applied herein to the Anopliidae is that used previously by the author (Archbold 1980).

Techniques: Small chonetacean specimens are frequently preserved with their valves conjoined and hence elucidation of the dorsal internal structure is impossible unless thin sections or peels are prepared. The peel technique has been seldom applied to the Chonetidina. Campbell (1953) and Muir-Wood (1962, pp. 112-113) used peels to assist in the determination of internal structures and the present author (op. cit. 1980) provided serial sections, in the form of peels, to confirm the internal structures of species of *Demonedys* and *Tornquistia.* The peels of *Tornquistia gregoryi* sp. nov. described herein were prepared by grinding and etching in the normal manner. Specimens were embedded in clear polyester resin and the block was ground at set intervals; a distance of 0.1 mm apart appears most suitable for the determination of cardinal structures. Etching of the ground surfaces was for three seconds using 10% HCl. Peels were made of the etched surfaces on sheet "celluloid" moistened with a solution of "celluloid" dissolved in acetone. The peels were projected on to photographic paper and outlines traced accurately. The orientation of calcite fibres is semi-diagrammatic.

SYSTEMATIC PALAEONTOLOGY

Suborder Chonetidina Muir-Wood 1955

Family Anopliidae Muir-Wood 1962

Subfamily Anopliinae Muir-Wood 1962
Genus **Tornquistia** Paeckelmann 1930

Type Species: Leptaena (*Chonetes*) *polita* McCoy 1852.

Diagnosis: Small, smooth anopliids with lateral septa and strongly developed accessory septa in the dorsal valve. Alveolus distinct. Cardinal process small, bilobed or weakly quadrilobate internally. Ventral valve strongly convex.

Discussion: The geographical and age ranges of the genus have previously been reveiwed by the author (op. cit. 1980) who demonstrated that numerous Permian species belonging to smooth genera of the Rugosochonetidae had incorrectly been assigned to *Tornquistia* (or *Paeckelmannia*). *Tornquistia* is readily distinguished from *Demonedys* Grant (1976) by the absence of a prominent ventral fold. *Anoplia* Hall and Clarke (1892), a genus superficially similar to *Tornquistia,* possesses a raised, internally bilobate cardinal process and long, curved, crenulated socket ridges. *Yagonia* Roberts (in Roberts et al. 1976) also possesses an elongate, bilobed cardinal process in addition to many pairs of spinose radial ridges between the short lateral septa and the pronounced accessory septa. *Yagonia* is also distinguished from *Tornquistia* by its remarkably large size.

Tornquistia gregoryi sp. nov.
(Plate 3, figs. 1-28; text figs. 1-2.)

Holotype: NMV P60709, a ventral valve, from Teichert's field locality WC(16-24) 1, described as "Wandagee Series, zones 16-24, northeast side of syncline, north of Minilya River, west of Coolkilya Pool." Now in Wandagee Formation.

Material: Four conjoined shells and 21 isolated ventral valves. One specimen was sectioned to reveal the internal structures.

Measurements: All specimens were measured and yielded the following ranges of measurements in mm. Graphical scatter plots are provided (fig. 1).

Maximum Width	Mid-width	Thickness	Length
11.4-6.7	10.8-6.3	3.8-2.1	8.8-2.1

Localities: After a reconnaissance visit in 1938, an area on Wandagee Station on the Minilya River in the Carnarvon Basin, was selected by Dr C. Teichert and others, then of the University of Western Australia, for detailed mapping. The mapping was begun in 1939 and continued in 1940 and 1941. The specimens described herein were collected during those years and came from the stratigraphic interval named by Teichert the Wandagee Series, *Calceolispongia* stage. That stratigraphic interval is now known as the Wandagee Formation. Specimens collected during those surveys are accurately located stratigraphically although geographically they are not so reliably located for, as Teichert (1949 p. 37) noted, "the type section of the Wandagee Series occurs in featureless, plain country which is singularly lacking in any kind of geographic features which could be named".

The localities of the specimens are recorded as follows.

Specimens NMV P60700-NMV P60712 are from Teichert's field locality WC (16-24)1, recorded as "Wandagee Series, zones 16-24, northeast side of syncline, north of Minilya River, west of Coolkilya Pool". Specimens NMV P60713-NMV P60724 are from Teichert's field locality WC (21-25)5, recorded as "Coley's locality E9 and station 29J of the 1939 survey; Wandagee Series, *Calceolispongia* stage, zones 16-24". Mr H. Coley, of Wandagee Station, was an indefatigable fossil collector, who became familiar with the stratigraphic occurrences of species of *Calceolispongia.*

Etymology: The species is named in honour of Augustus Charles Gregory, pioneer explorer of the Swan River Colony and one of the first to investigate the Permian rocks of Western Australia.

Description: Medium size for genus; convexity low in juveniles, higher in adults. Mesial portion of ventral valve inflated, at times with a weak ventral fold posteriorly developed, other specimens with a higher convex ventral valve. Greatest width usually at hinge line; occasional specimens develop a rounded quadrate outline with mid-width equal to or slightly greater than hinge width. Interareas low. Dorsal valve gently concave. Exterior of shell smooth with weakly

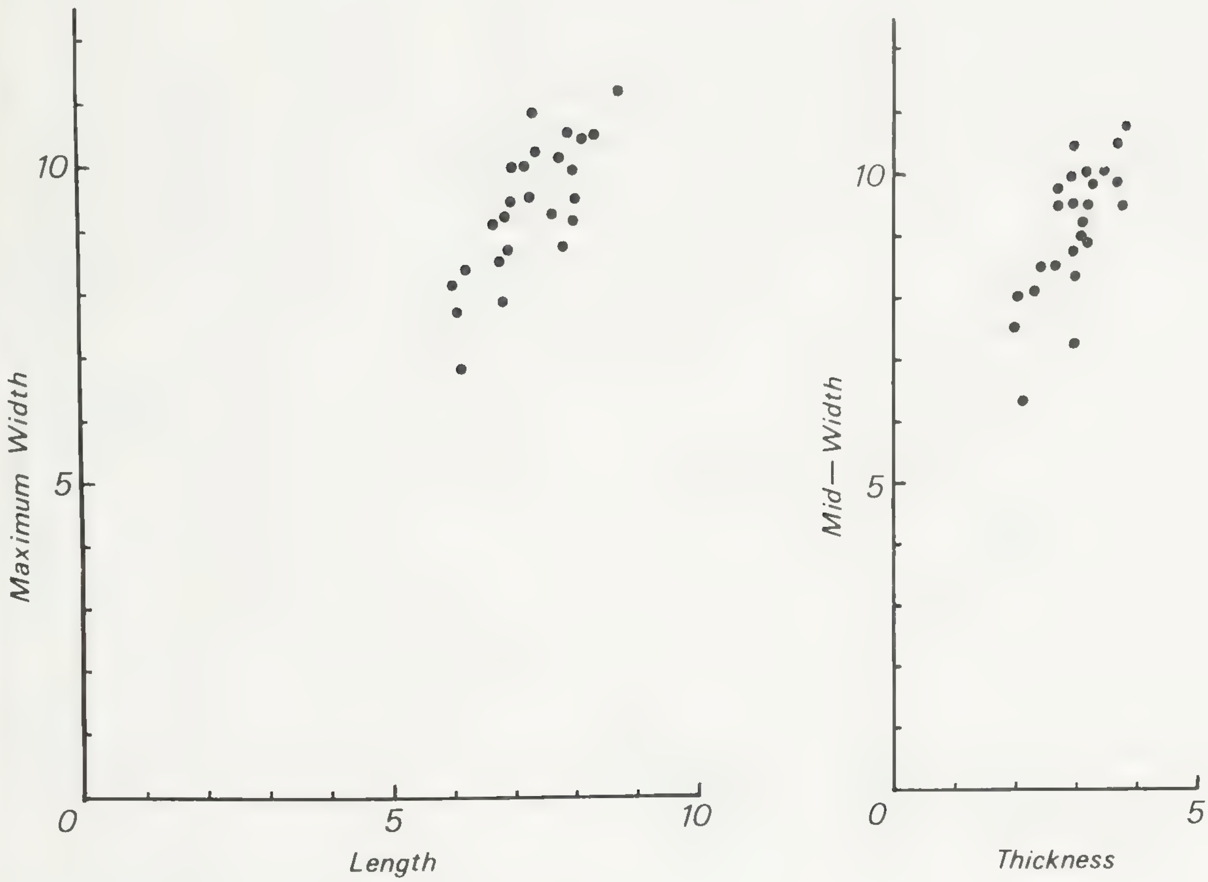


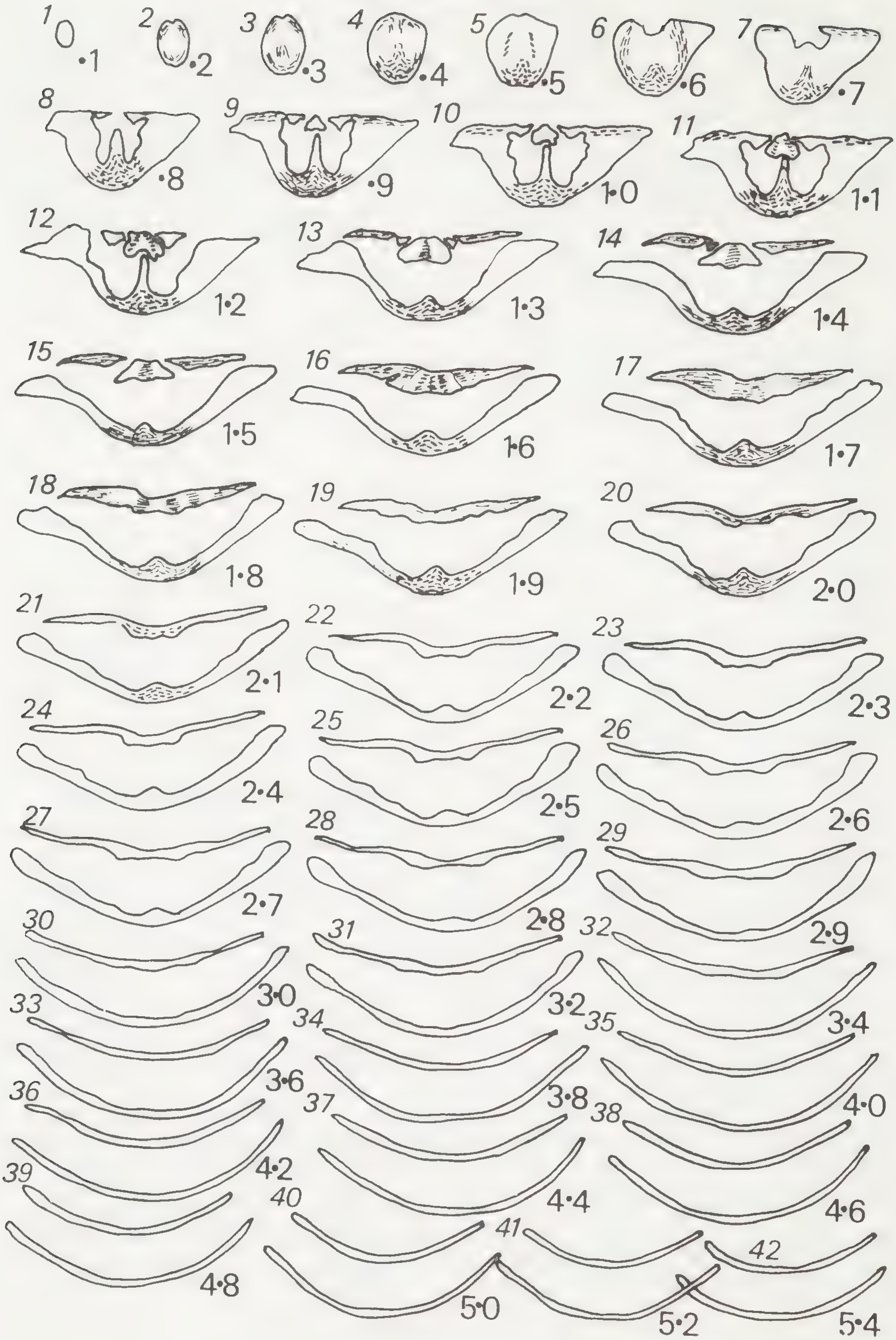
Fig. 1—Scatter Plots (in mm) of measurements of *Tornquistia gregoryi* sp. nov.

developed growth lines. Cardinal spines poorly known, apparently short and well spaced.

Ventral interior with well developed teeth, delthyrium wide; ventral median septum high posteriorly, articulating with slot between halves of bilobed cardinal process, lower anteriorly, extending for about one half valve length. Valve floor, excluding muscle region, with scattered pustules.

Dorsal interior with strongly bilobed cardinal process. No median septum. Accessory septa well developed, extending anteriorly as gently diverging, distinct ridges for two-thirds valve length. Lateral septa short, low. Anterior of valve strongly pustulose except for region between the accessory septa.

Observations on the peels of Tornquistia gregoryi: Forty-two peels were prepared from the parallel serial grinding of a complete shell of *T. gregoryi*; the first thirty peels being at 0.1 mm distance apart, the subsequent peels at 0.2 mm apart. The full set is shown in Fig. 2. The ventral median septum is obvious by peel no. 8 and in peels 10 to 12 can be seen to be articulating with the bifid cardinal process. Peel 12 indicates the pronounced bifid nature of the interior of the cardinal process. An additional weakly developed lateral groove adjacent to the strong median groove on the internal face of the cardinal process in peel 12 may indicate a tendency for the cardinal process to be weakly quadrilobate. Weakly developed low lateral septa are indicated in peels 17-19 and the accessory septa arise gently in peel 17 and persist anteriorly until peel 32, hence being almost 2 mm long. The ventral median septum persists until peel 29 and hence is about half the length of the valve. The anterior sections of the two valves reveal the thin nature of the shell anteriorly.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Discussion: This distinctive species, characterized by the incipient development of a ventral fold posteriorly in many specimens and the high, arched convexity of mature individuals is readily distinguished from other species of the genus. *Tornquistia magna* Archbold (1980 p. 186 pl. 25, figs. 5-13) also is characterised by the possession of a highly convex ventral valve with a strongly inflated mesial portion of the valve; however, no trace of an incipient ventral fold occurs in *T. magna* unlike *T. gregoryi*. *T. gregoryi* is probably a direct descendant of *T. magna*. Other Western Australian species of *Tornquistia* are normally not as strongly convex as *T. gregoryi*. True *Tornquistia* is relatively rare in Permian strata (cf. discussions in Archbold 1980 p. 184) and of foreign species only *T. gibbera* Afanas'yeva (1977) from the Late Carboniferous or Early Permian (Asselian) Paren Horizon of the Kolyma-Omolon region, USSR, need be compared with *T. gregoryi*. The Siberian species is distinctly convex; however, no trace of an incipient median fold is present and the dorsal internal septa are weakly developed in comparison with the strongly developed accessory septa of *T. gregoryi*.

The presence of an incipient, posteriorly developed, ventral fold in *T. gregoryi* recalls the genus *Demonedys* Grant (1976). However, that genus is characterised by species small in size and with a pronounced ventral fold and hence should not be confused with *Tornquistia* (cf. Grant 1976, Archbold 1980). The ventral median septum of *Demonedys* is short and high unlike the relatively long septum of *Tornquistia*. Nevertheless the discovery of a species of *Tornquistia* with an incipient ventral fold supports the view of Archbold (1980. p. 183) that *Demonedys* developed from a *Tornquistia* stock.

Archbold (1980, p. 188) referred several poorly preserved specimens from the Wandagee Formation to *Demonedys*. Re-examination of these specimens indicates that they could just as readily be immature specimens of *T. gregoryi* hence it is now assumed that *Demonedys granti* is restricted to the Cundlego Formation of the Carnarvon Basin until proven otherwise.

Fig. 2—*Tornquistia gregoryi* sp. nov. Transverse serial sections of specimen NMV P60706, x5. The larger numbers refer to the position of the section, in mm, from the posterior extremity of the shell. Orientation of calcite fibres is shown semi-diagrammatically. Pseudo-punctae (taleolae) not shown.

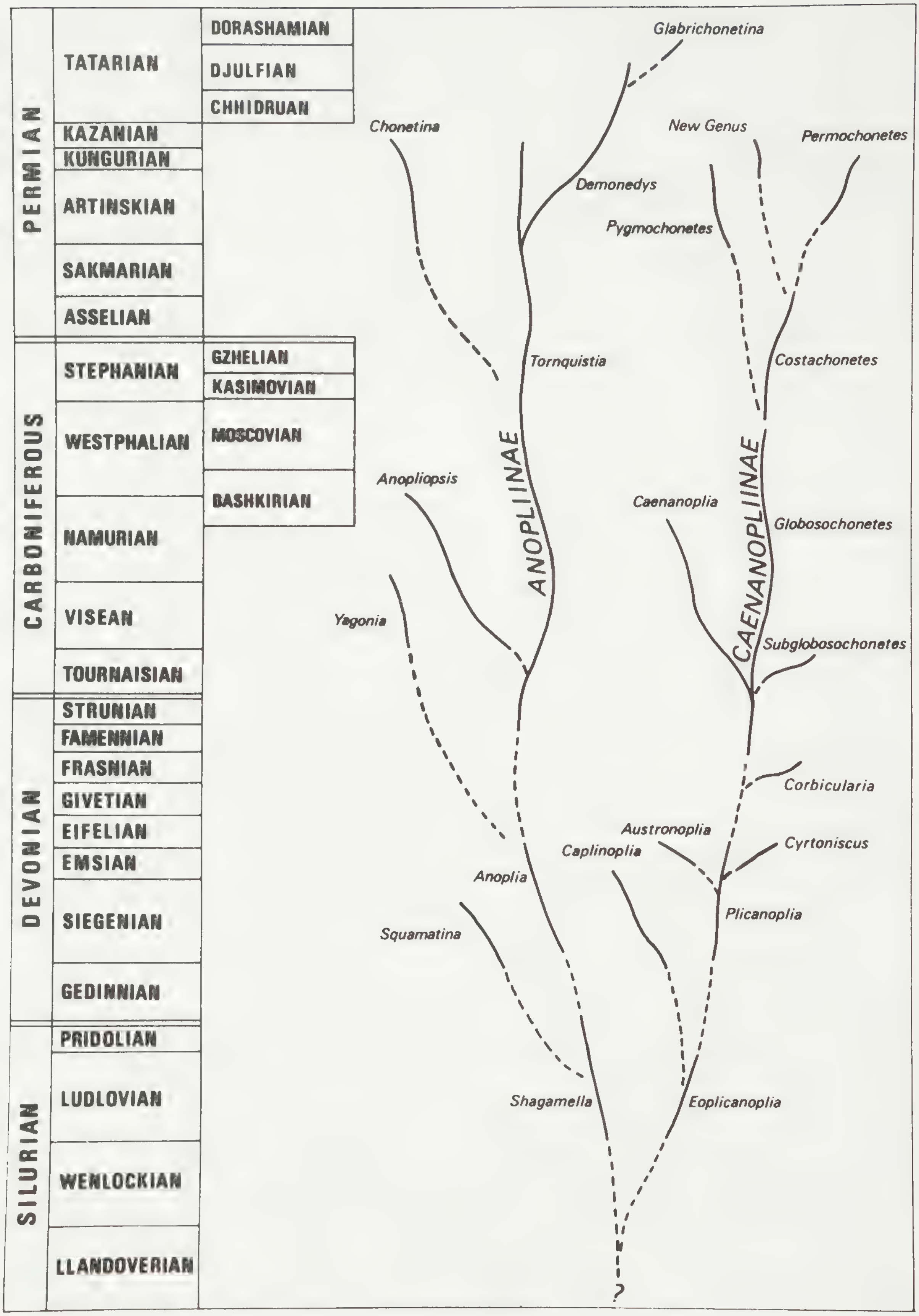
PHYLOGENY OF THE ANOPLIIDAE

A detailed account of the inferred phylogeny of the Anopliidae has been given by the author (Archbold 1980) but the works of Jing and Hu (1978) and Havlicek and Racheboeuf (1979) necessitate amendments to that account.

Caplinoplia Havlicek and Racheboeuf from the Siegenian and Emsian of Czechoslovakia is a caenanopliinid with strong, long, curved lateral and accessory septa and a short, anteriorly placed median septum, in the dorsal valve. It is probably a descendent of *Eoplicanoplia* Boucot and Harper (1968), a Ludlovian genus with lateral septa and a variably developed dorsal median septum, rather than being an off shoot from *Plicanoplia* Boucot and Harper (1968), a Siegenian genus with lateral and accessory septa but no median septum, in the dorsal valve.

Pygmochonetes Jing and Hu (1978) a caenanopliinid from the Artinskian-Kungurian of China possesses similar internal structures to *Costachonetes* Waterhouse (1975) but *Costachonetes* invariably possesses a variably developed ventral sulcus, at least posteriorly (Archbold 1980 pp. 183, 189; Prokof'ev 1975 p. 17, pl. 1, figs 8-14). *Pygmochonetes*, characterised by a strongly inflated ventral valve with a highly arched median section, apparently includes *Chonetella dubia* Loczy (1897, p. 67, text fig. 16) from the Late Carboniferous of China, a species indicated by Archbold (1980, p. 181) to possibly belong to a new genus. *Pygmochonetes* and *Costachonetes* may have evolved independently from *Globosochonetes* as indicated by Archbold (1980, p. 183) or *Pygnochonetes* may have evolved from early *Costachonetes*.

I now include *Yagonia* Roberts (in Roberts et al. 1976) within the Anopliinae. *Yagonia* was possibly derived from *Anoplia*, as indicated on text fig. 3, but this remains one of the



PERMIAN
TATARIAN
DORASHAMIAN
DJULFIAN
CHHIDRUAN
KAZANIAN
KUNGURIAN
ARTINSKIAN
SAKMARIAN
ASSELIAN
CARBONIFEROUS
STEPHANIAN
GZHELIAN
KASIMOVIAN
WESTPHALIAN
MOSCOVIAN
BASHKIRIAN
NAMURIAN
VISEAN
TOURNAISIAN
DEVONIAN
STRUNIAN
FAMENNIAN
FRASNIAN
GIVETIAN
EIFELIAN
EMSIAN
SIEGENIAN
GEDINNIAN
SILURIAN
PRIDOLIAN
LUDLOVIAN
WENLOCKIAN
LLANDOVERIAN
Glabrichonetina
Chonetina
New Genus
Permochonetes
Demonedys
Pygmochonetes
Tornquistia
Costachonetes
ANOPLIINAE
CAENANOPLIINAE
Anopliopsis
Caenanoplia
Globosochonetes
Yagonia
Subglobosochonetes
Corbicularia
Austronoplia
Caplinoplia
Cyrtoniscus
Anoplia
Plicanoplia
Squamatina
Shagamella
Eoplicanoplia
?

more hypothetical relationships within the Anopliinae.

Finally, *Squamatina* Havlicek and Racheboeuf (1979, p. 109), a genus of typical anopliinid size and shape from the Siegenian of Czechoslovakia may be an atypical descendent of *Shagamella* Boucot and Harper (1968). Havlicek and Racheboeuf (1979, p. 109) noted the external similarity of *Squamatina* to *Anoplia* and that the internal structures of *Squamatina* were atypical of the Anopliidae, with which I agree, nevertheless, *Shagamella*, the earliest known member of the Anopliinae, possesses poorly developed *or no* accessory septa and hence is similar to its chonetid ancestory. *Squamatina* can be interpreted as a member of the Anopliidae also possessing interior characters of the Chonetidae, the ancestors of the Anopliidae.

Other genera and relationships shown in text fig. 3 are discussed in Archbold (1980) with the exception that *Chonetes* (*Chonetina*) *westphalicus* Böger & Fiebig (1963, pp. 147-148) from the Westphalian of Germany is now placed in *Tornquistia* following Winkler Prins (1970, p. 3) and Brand (1970, p. 100). This, in turn, leaves the origin of *Chonetina* open to question.

Acknowledgements

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Fig. 3—Inferred phylogeny of the Family Anopliidae Muir-Wood (modified from Archbold 1980, p. 182).

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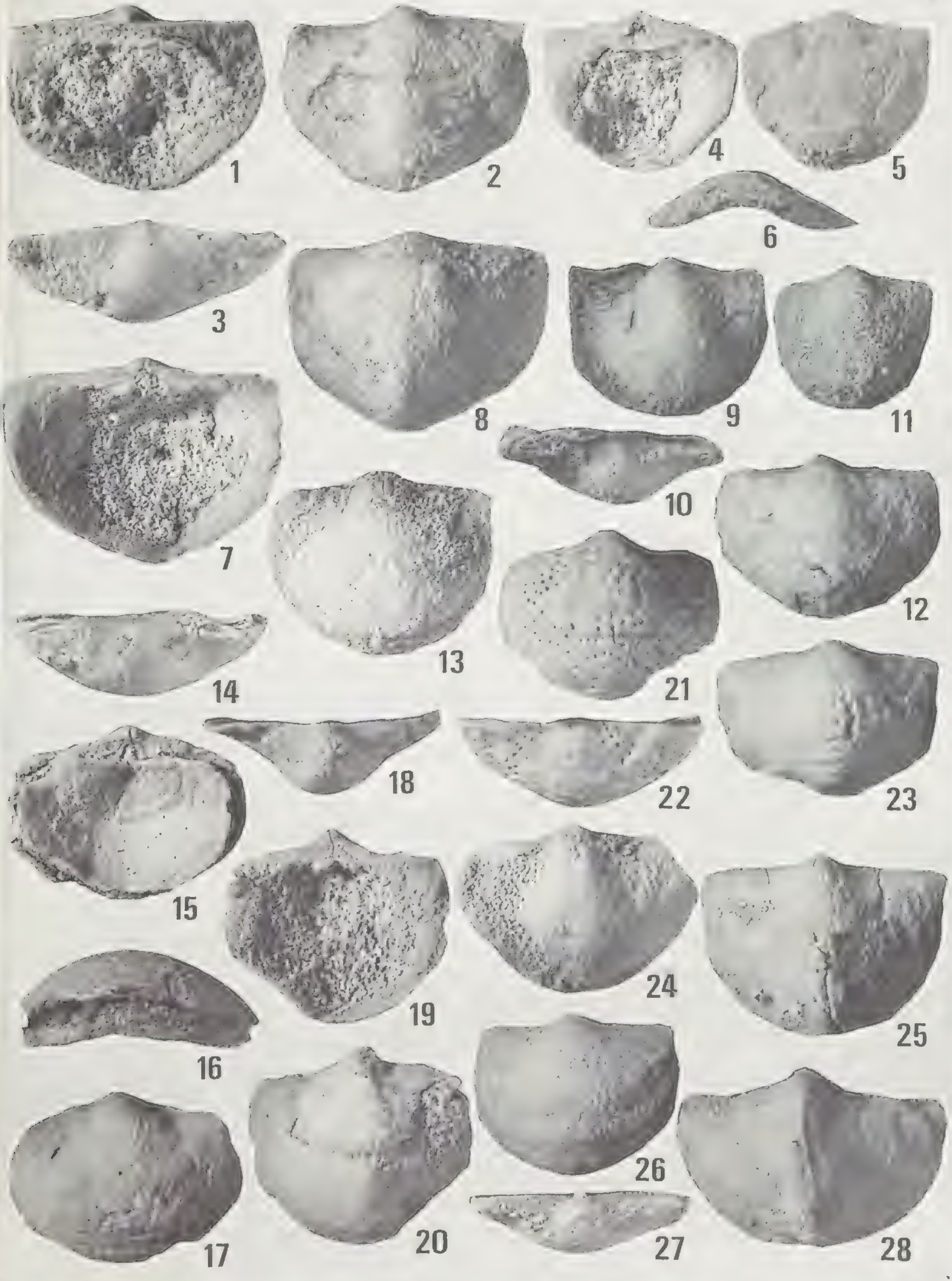
Explanation of Plate

PLATE 3

Tornquistia gregoryi sp. nov. All figures x4.5.

Figs. 1-3. NMV P60715. Dorsal, ventral and posterior views of shell.
Figs. 4-6. NMV P60712. Dorsal, ventral and anterior views of shell.
Figs. 7-8. NMV P60713. Dorsal and ventral views of ventral valve.
Figs. 9-10. NMV P60718. Ventral and posterior views of ventral valve.
Figs. 11. NMV P60724. Ventral view of ventral valve.
Figs. 12. NMV P60707. Ventral view of ventral valve.
Figs. 13. NMV P60716. Ventral view of ventral valve.
Figs. 14-17. NMV P60706. Posterior dorsal, anterior and ventral views of shell.
Figs. 18-20. NMV P60709. Holotype. Posterior, dorsal and ventral views of ventral valve.
Figs. 21-22. NMV P60717. Ventral and posterior views of ventral valve.
Figs. 23. NMV P60708. Ventral view of ventral valve.
Figs. 24. NMV P60705. Ventral view of ventral valve.
Figs. 25. NMV P60702. Ventral view of ventral valve.
Figs. 26-27. NMV P60710. Ventral and posterior views of ventral valve.
Figs. 28. NMV P60700. Ventral valve in ventral view.



LATE EOCENE AND EARLY OLIGOCENE TURRIDAE (GASTROPODA: PROSOBRANCHIATA) OF THE BROWN'S CREEK AND GLEN AIRE CLAYS, VICTORIA, AUSTRALIA

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Abstract

Over 50 species of fossil gastropod belonging to the family Turridae or to turrid like genera occur in the late Eocene Brown's Creek Clay and the early Oligocene Glen Aire Clay of south west Victoria, Australia. As with other fossils from these deposits distinctive assemblages can be identified for various horizons—in this case BC1 and BC3 in the Brown's Creek Clay, and the horizon present at Geological Survey of Victoria locality AW1 in the Glen Aire Clay. Evidence from the turrids would thus give local stratigraphic correlations and it tends to support wider correlations achieved by other means. One specific identification is made with a New Zealand fossil of approximately the same age and there is evidence of common elements, some localised, in the late Eocene turrid faunas of the two areas. At the generic level the turrid fauna indicates conservatism; twelve possibly, thirteen, of the genera reported in this paper are still present in Australasian and Indo-Pacific waters.

New taxa proposed are: *Comitas wynyardensis cudmorei* subsp. nov., *Makiyamaia victoriae* sp. nov., *Apiotoma? wilkinsoni* sp. nov., *Johannaia darraghi* gen. et. sp. nov., *Marshallaria otwayensis* sp. nov., *Paramarshallena propebelloides* gen. et. sp. nov., *Turrinosyrinx denticulata* sp. nov., *Gemmula (Clavogemmula) prima* subgen et sp. nov., *Borsonia tatei eocenica* subsp. nov., *Cryptocordieria variabilis* gen. et sp. nov., *Splendrillia hughesi* sp. nov., *Mauidrillia secta otwayensis* subsp. nov., *Conorbis atractoides otwayensis* subsp. nov. *Guraleus eocenicus* sp. nov., *Macteola eocenica* sp. nov., *Syngenochilus johannaensis* sp. nov., *Parasyngenochilus eocenicus* gen. et. sp. nov., *P. angustior* sp. nov.

Introduction

This paper is based on collections of fossils in the National Museum of Victoria, with some additional material from the collection of the writer. Three horizons are involved (Text Figure 1):

Locality FL11, BC1, 7.6 m dark grey clay with *Turritella* below greensand in Brown's Creek Clay, Washout 1 nearest Brown's Creek, Grid Reference Aire 277177; late Eocene (Abele *et al.*, 1976:225);

Locality FL13, BC3, 16 m of dark gritty clay above greensand, Brown's Creek Clay, Washout 1, Aire 277177, and FL14, BC3, dark gritty clay in Washout 2, forked gully nearest mouth of Johanna River, Aire 276179; late Eocene (Abele *et al.*, 1976:225);

Locality FL19, Geological Survey of Victoria locality AW1, Glen Aire Clay, Point Flinders, Cape Otway, Victoria, Aire 367097; early Oligocene (Abele *et al.*, 1976:226).

Although nearly 120 molluscan species have been described from the Australian Eocene and early Oligocene, nearly all by Tate (1878, 1886, 1888, 1890, 1893) from Blanche Point, Aldinga or from the Adelaide (Kent Town) Bore both South Australia, these include only nine names proposed for members of the turridae. No new species of Mollusca have yet been described from the Brown's Creek Clay though the fauna is under study by T. A. Darragh, National Museum of Victoria. That this fauna is incompletely described is owing partly to the size of the problem facing palaeontologists working on the Australian Tertiary, partly owing to the inaccessibility of some of the localities, and also to the difficulties faced by early workers in dating Australian marine Tertiary deposits on a global basis. It is the aim of this report to fill one gap by description of the late Eocene and early Oligocene Turridae of Victoria.

Classification

The family Turridae Swainson, 1840 (emended), with the Conidae and Terebridae forms a heterogenous part of the Superfamily Conacea within the Prosobranch Suborder Stenoglossa. It is distinguished by the members possessing a more or less toxoglossate radula and, in general, fusiform shells with a pronounced posterior sinus produced by the mantle edge curving round the anal siphon. The inner shell of the spire whorls is not, except in the genus *Conorbis*, resorbed as it is in the Conidae. Within these criteria the genera of the family exhibit a considerable variety of form

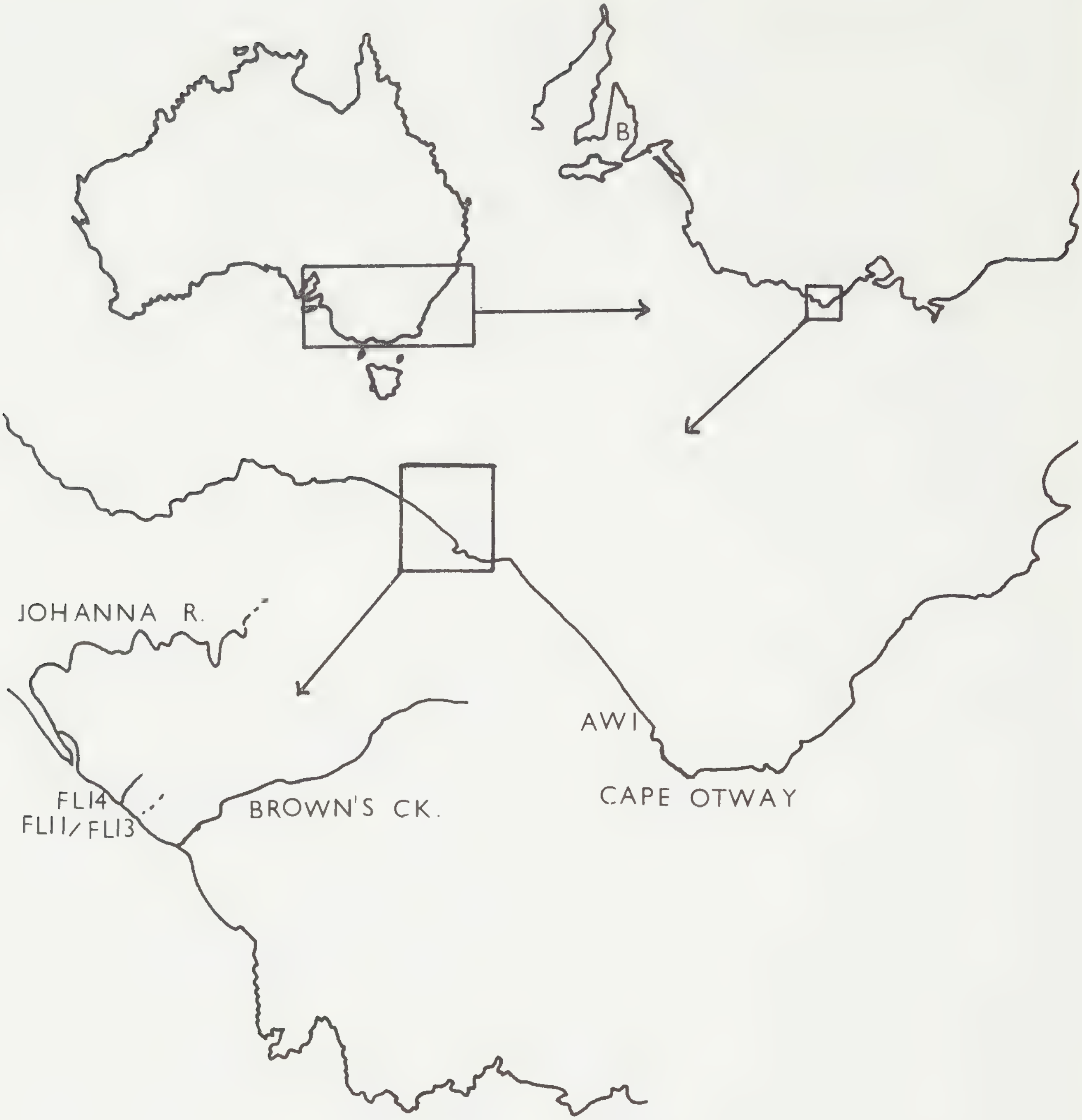

Fig. 1. Late Eocene-Early Oligocene fossil localities.
B = Blanche Point Aldinga.

often closely resembling genera of other families such as the Pyrenidae, Mitridae, or Buccinidae.

Various features have been used to attempt subfamilial classifications of the Turridae—the operculum or its absence (Fischer, 1887), the protoconch (Hedley, 1922, in conjunction with the operculum), the radula (Thiele, 1929), or, more recently a combination of characters (Powell, 1942; Powell, 1966; McLean, 1971). These latter classifications appear to be a better approximation to natural groupings than the earlier ones, but all such classifications must contain areas of uncertainty which derive partly from the great fossil and Recent diversity of the Turridae and partly from the fact that the vast majority of Recent species are still known only from shells.

The position is further complicated when dealing with fossils because one is forced ultimately to work from analogies with the shells of the Recent fauna. With the Turridae the only diagnostic shell feature for the family is the posterior sinus, and though a clearly identifiable sinus is a positive indicator for the family placement, its absence does not definitely eliminate a shell from consideration as a turrid. For this reason the ascription of many genera and species to the Turridae is doubtful, and further examples are given here, since a notable proportion of the Eocene and early Oligocene turrid-like fossils found in Victoria have a weak to very weak posterior sinus which makes their subfamilial or even familial placement uncertain.

The subfamilial divisions and order advocated by Powell (1966) have been used in this paper as they seem reasonably well adapted to the Australasian region, although the species of *Turrinosyrinx* and *Rugobela* dealt with below illustrate the difficulty of relying on shell characters to determine subfamilial classifications in the Turridae. In the Victorian Eocene and early Oligocene turrids are found which would fall into the Subfamilies Cochlespirinae,* Turrinae, Borsoniinae, Clavinae, Conorbiinae Mangeliinae and, atypically, the Daphnellinae.* Species whose familial placement is uncertain are dealt with at the end of the systematic descriptions.

Terminology and Definitions

For the purposes of this report the shell is basically divided into two portions:

(a) the protoconch which is the larval shell and here includes parts of the shell grown during the planktonic larval stage; the sculpture differs from the teleoconch;
(b) the teleoconch which includes the shell formed during immaturity, adulthood and old age.

The junction between the protoconch and teleoconch may be sharp and clearly defined, or there may be no clear break as elements of the teleoconch successively develop.

The term posterior sinus describes the adapical curvature of the outer lip of the aperture. This may be located in a sulcus. Most of the fossils considered here have suffered apertural damage and the shape of the posterior sinus has had to be deduced from the curvature of the axial growth lines.

All measurements are in millimetres.

L (Length) is the distance from the tip of the protoconch to the distal end of the anterior canal;

B (Breadth) is the maximum diameter of the body whorl at its periphery;

S (the Spire Height) is measured from the posterior suture at the top of the aperture to the tip of the protoconch.

Whorl counts are given separately for the protoconch and teleoconch.

Registration numbers prefixed with a P are those of the National Museum of Victoria (NMV); numbers prefixed with EA, EB, or EW are for material in the writer's collection.

Discussion

The major features of the three diverse faunas reviewed here are generic conservatism—many genera still live in Australasian

* Following Cernohorsky (1972b: 127), Cochlespirinae Powell, 1942 is used in preference to Turriculinae Powell, 1942 (*non* Turriculidae Carpenter, 1861, Turriculinae A. Adams, 1864). The writer uses Daphnellinae Casey, 1904 pending resolution of whether Raphitominae Bellardi, 1875 has priority for this subfamily.

and Indo-Pacific waters* or have long fossil records† — coupled with relatively rapid specific change as the listing of the fauna in Table 1 and the species level comparisons in Table 2 show. These reflect abilities to simultaneously maintain existing forms and evolve new lineages which appear to be characteristic of the Turridae throughout the Cenozoic since collation of the time range data on the family, worldwide, contained in Powell (1966) suggests that the proportion of genera implied as surviving from earlier epochs was about 5% in the Paleocene, 15% in the Eocene, 56% in the Oligocene and Miocene, 82% in the Pliocene and 96% in the Pleistocene, while new genera appeared at an approximate rate of 1.3 genera: MYr in the Paleocene, 3.8: MYr from the Eocene to the end of the Pliocene, and 2.7:MYr in the Pleistocene.

Because of this generic conservatism the turrids are mostly poor indicators of general age. However the presence of *Johannaia* (possibly allied to the Palaeocene *Eopleurotoma*) in BC1, *Tholitoma* (otherwise Paleocene — late Eocene New Zealand) in BC3, *Turrinosyrinx* (elsewhere Palaeogene) in all three faunas, *Marshallaria* (otherwise Palaeocene-Oligocene New Zealand) in AW1, and *Conorbis* (mainly Cretaceous-Oligocene) in BC3 and AW1 suggests that the faunas are Palaeogene.

Specific and subspecific changes between BC1 BC3 and AW1 clearly indicate that three separate faunal horizons are involved. No horizon has more than 41% of its species in common with any other (BC1 with BC3, Table 2). No identifications have been made with any species occurring later than the Longfordian (early Miocene) — *Syngenochilus radiapex*, again supporting a Palaeogene dating in general. More constraining is the specific identicality of several turrids‡ with those occurring in the Blanche Point Formation at Aldinga, South Australia. This phenomenon is best marked in the BC3 fauna; in BC1 and AW1 species in common with the Blanche Point Formation are nearly all recognizably different subspecifically. These findings are consistent with micro-palaeontological evidence (Abele *et al.*, 1976: 225-226), and it is not surprising that the turrids should have some local correlative value as this has already been demonstrated in other south east Australian Cenozoic mollusca (Darragh 1969, 1971).

The marked decrease in diversity in the AW1 turrid fauna compared with BC3 — 9 fewer genera and 12 fewer species — may possibly be associated with the major climatic cooling event at the Eocene-Oligocene boundary for which there is a mounting body of evidence (e.g. Keigwin, 1980). There is some evidence that benthic molluscan faunas were affected: Marincovich (1977:200) reported than the greatest extinction among Cenozoic naticids of western North America occurred at the close of the Eocene, and that early Oligocene naticids in the area suggested a distinctly cooler shallow-water hydro-climate than the late Eocene, and the reduction in the number of Indo-Pacific migrants into the New Zealand fauna in the Runangan stage (Fleming, 1967) may also be related. Furthermore data in Powell (1966) suggests that the Turridae in general were affected since about 46% of the genera whose presence is implied in the Eocene did not survive into the Oligocene while the corresponding Oligocene-Miocene figure is about 12%. When considered in detail, however, the evidence from the AW1 turrid fauna is inconclusive as an indicator of major palaeoenvironmental deterioration as there is as yet insufficient information on the distribution and temperature tolerances of the genera involved.

The three turrid faunas are fairly typical of the Palaeogene in that the Cochlespirinae, Borsoniinae and Clavinae are well represented, the Daphnellinae very little (one typical genus — *Asperdaphne*) and the Mangeliinae not in large numbers. With only two species of Turrinae (three if *Johannaia* is included) the assemblage differs from the European area where *Gemmula, Eopleurotoma* and their relatives are conspicuous; *Clavogemmula* and *Johannaia*

* *Comitas, Apiotoma, Makiyamaia, Cochlespira, Borsonia, Mitrolumna, Splendrillia,* perhaps *Conorbis, Guraleus, Antiguraleus, Macteola, Etrema* and *Asperdaphne.*

† *Veruturris, Mauidrillia* and *Rugobela.*

‡ *Comitas aldingensis, Makiyamaia victoriae, Cochlespira semiplana, Mauidrillia aldingensis, M. secta, Guraleus eocenicus.*

TABLE 1

Species of **Turridae** in the Brown's Creek and Glen Aire Clays

Species	BC1	BC3	BP	AW1	Jan	Mioc. Aust.	Plioc. Aust.	Recent Aust.	Recent Else-where
1. *Comitas?* sp.	S								
2. *C. aldingensis*		S	S	G	G	G		G	G
3. *C. w. cudmorei*				SS	SS				
4. n.gen.? sp. a.			S						
5. n.gen.? sp. b.		S							
6. n.gen.? sp. c.		S							
7. *Tholitoma* sp.		S							
8. *M. victoriae*	S	S	S						G
9. *Apiotoma?* sp. a.	S								
10. *Apiotoma?* sp. b.	S								
11. *Apiotoma? wilkinsoni*		S							
12. *A. bassi*				S	G	G			G
13. *?Insolentia* sp.		S			G				
14. *M. otwayensis*				S					
15. *P. propebelloides*	S	S							
16. *C. semiplana*	S		S		G	G		G	G
17. *T. denticulata*	S	S		S					
18. *J. darraghi*	S								
19. *G. prima.*	S								
20. *Veruturris* sp.		S				G	G		
21. *Cordieria?* sp.	S								
22. *C. cf protensa*		S							
23. *C. protensa*				S					G
24. *?C.* sp.		S							
25. *B. t. eocenica*	SS				SS	G?		G	G
26. *?B.* sp. *aff tatei*		S							
27. *?Mitrolumna* sp.		S				G		G	G*
28. *C. variabilis*	S	S							
29. *?Splendrillia* sp.	S	S							
30. *S. hughesi*				S	G	G	G	G	G
31. *?Hauturua* sp.		S					G		G
32. *M. aldingensis*		S	S	G	G	G			
33. *M. secta*	SS	SS	SS	SS					
34. ?n. gen et sp.		S							
35. *Conorbis* sp.		S							G?
36. *C. a. otwayensis*				SS					
37. *G. eocenicus*	S?	S	S	S	G	G	G	G	
38. *Antiguraleus* sp. a.		S		S	G	G	G	G	G*
39. *Antiguraleus* sp. b.				S					
40. *?Antiguraleus* sp. c.		S		S					
41. *M. eocenica.*	S	S						G	
42. *Etrema* sp.				S	G	G	G	G	G
43. *Asperdaphne* sp. a.	S	G	G	G		G	SG	G	G
44. *Asperdaphne* sp. b.	S		S	S					
45. *Asperdaphne* sp. c.		S							
46. *R. humerosa*	S				G	G			
47. *S. johannaensis*	S			G	G	G			
48. *S. radiapex*				S	S				
49. *P. eocenicus*		S		G					
50. *P. angustior*				S					
51. *?P.* sp. a.	S								
52. *?P.* sp. b.	S	S							

G = genus occurs; SG = subgenus occurs; S = species occurs; SS = subspecies occurs; BP = Blanche Point Formation; Jan. = Janjukian; Aust. = Australia; * = New Zealand.

TABLE 2

Victorian Eocene-early Oligocene Turridae

Numbers and Percentages (in brackets) of Species in common

	BC1	BC3	AW1	Janjukian
BC1	22 (100)	9 (41)	4 (18)	1 (4.7)
BC3	9 (32)	28 (100)	5 (18)	0 (0)
AW1	4 (25)	5 (31)	16 (100)	2 (13)

may be regarded as local equivalents of *Gemmula* and *Eopleurotoma* but they have only been found so far in BC1. Cosmopolitan genera in the fauna amount to about 28% in BC1, 25% in BC3 and 21% in AW1; Indo-Pacific genera 28%, 30% and 36%; genera so far recorded only from Australia and New Zealand 18%, 25% and 29%, and genera apparently confined to southern Australia 28%, 20% and 14%; these percentages should be treated with caution as they are based on the small numbers of genera in each fauna and can easily be affected (as is the case of the southern Australian element) by taxonomic decisions, but the relatively high cosmopolitan element is roughly in accord with Darragh's (1980) finding on the Cenozoic mollusca of south east Australia as a whole.

Since Palaeogene marine deposits do not appear to have been reported yet from the east Antarctic continental shelf the only geographically close faunas outside Australia which are well enough known for comparison are those of New Zealand—in particular the Bortonian and Kaiatan (late Eocene); only *Austrotoma* was recorded from the New Zealand early Oligocene (Fleming, 1966), but P. A. Maxwell (pers. comm. 5.1.1981) also reports *Rugobela.*

Rugobela humerosa (Marwick, 1926) occurs both in the Kaiatan and BC1, but it has not so far been possible to equate any other New Zealand Eocene turrid species with south east Australian fossils. Nevertheless there are similarities; these stem in part from their having features in common with world-wide Palaeogene turrid faunas, such as a strong representation of Cochlespirinae, and also in part from the presence of smaller phylogenetic groups in which the same genus or related genera occur in both areas (Table 3). Some of these have both cosmopolitan or Indo-Pacific affinities and local representatives (*Apiotoma/Zemacies, Gemmula/G.(Clavogemmula), Cochlespira/Turrinosyrinx/Tahusyrinx* and the Borsoniinae). Others are more local, notably *Tholitoma, Rugobela* and the problematic *Syngenochilus/Parasyngenochilus* group, but caution must be exercised in claiming highly localized groups of genera as further work elsewhere may well reveal major extensions of range (as with *Parasyrinx* in Hickman, 1976 or *Turrinosyrinx*, this paper). There are also some differences, in particular the presence of *Conorbis*, a more numerous Clavinid representation, Mangeliinae and *Asperdaphne* in south east Australia. In general all these late Eocene-early Oligocene turrid faunas reflect local development from a diversity of turrid lineages that had already become widely, in some cases globally, dispersed by the late Eocene.

None of the fossils recorded in this paper extend the known time range of the subfamilies recognised by Powell, 1966, but the presence of *Guraleus*, probably *Antiguraleus*, and *Macteola* in the Australian late Eocene is interesting since otherwise (Powell, 1966: 22-23) Eocene records of Mangeliinae are European and North American. A number of generic ranges are extended back in time—*Veruturris* (late Eocene vice early Miocene-Pliocene); *Mitrolumna* (possibly late Eocene, vice Oligocene-Recent), *Asperdaphne* (late Eocene, vice middle Miocene-Recent) and *Syngenochilus* (late Eocene-late Oligocene, vice late Oligocene only). Additionally the range in Australia of *Rugobela*, and probably *Apiotoma* is extended back to the late Eocene.

Systematic Description

Sub-family COCHLESPIRINAE Powell, 1942

Genus **Comitas** Finlay, 1926

Type species (o.d.) *Surcula oamarutica* Suter, 1917 = *Drillia fusiformis* Hutton, 1877.

Diagnosis: Protoconch papillate, of two smooth whorls, carinate or subcarinate over the last whorl. Teleoconch elongate fusiform with a tall spire and moderately long, slightly flexed,

TABLE 3

Comparison of the Bortonian and Kaiatan turrid faunas of New Zealand with the late Eocene and early Oligocene Turridae of Victoria, Australia

	Bortonian	BC1	Kaiatan	BC3	AW1
	–	*Comitas?*	–	*Comitas*	*Comitas*
	–	–	*Tholitoma*	*Tholitoma*	–
	–	*Makiyamaia*	–	*Makiyamaia*	–
	Zemacies	*?Apiotoma*	*Zemacies*	*?Apiotoma*	*Apiotoma*
	Insolentia	–	–	*?Insolentia*	–
Cochlespirinae	*Marshallena*	*Paramarshallena*	*Marshallena*	*Paramarshallena*	–
	Marshallaria	–	*Marshalleria*	–	*Marshallaria*
	Notogenota	–	*Notogenota*	–	–
	–	*Cochlespira*	–	–	–
	–	*Turrinosyrinx*	*Tahusyrinx*	*Turrinosyrinx*	*Turrinosyrinx*
	–	*Johannaia*	–	–	–
	–	–	*Eoturris*	–	–
Turrinae	*Gemmula*	*G (Clavogemmula)*	*Gemmula*	*Veruturris*	–
	Borsonia	*Borsonia*	–	*?Borsonia*	–
	–	*?Cordieria*	*Cordieria*	*Cordieria*	*Cordieria*
Borsoniinae	–	*Cryptocordieria*	–	*Cryptocordieria*	–
	–	–	*Eoscobinella*	–	–
	–	–	–	*?Mitrolumna*	–
Clavinae	–	*?Splendrillia*	–	*?Splendrillia*	*Splendrillia*
	–	*Inquisitor*	–	–	–
	–	*Mauidrillia*	–	*Mauidrillia*	*Mauidrillia*
	–	–	*Tahudrillia*	–	–
Conorbiinae	–	–	–	*Conorbis*	*Conorbis*
	–	*Guraleus*	–	*Guraleus*	*Guraleus*
Mangeliinae	–	–	–	*Antiguraleus*	*Antiguraleus*
	–	–	–	*Macteola*	–
	–	–	–	–	*Etrema*
Daphnellinae	–	*Asperdaphne*	–	*Asperdaphne*	*Asperdaphne*
	–	*Rugobela*	*Rugobela*	–	–
Uncertain	–	*Syngenochilus*	–	–	*Syngenochilus*
	–	*Parasyngenochilus*	*Parasyngenochilus*	*Parasyngenochilus*	*Parasyngenochilus*

New Zealand data based on Fleming, 1966 with additions from P. Maxwell (pers. comm.).

unnotched anterior canal. Adult sculpture of long fold-like axials crossed by dense spiral lirae. Suture marginated by a weak fold at most. Sinus moderately deep, rather broadly U-shaped, on the shoulder slope but nearer to the periphery than to the suture (after Powell, 1966: 28).

?Comitas sp.
(Plate 4, figure 1)

Comments: A *Comitas*-like shell characterised by its long slightly concave shoulder slope and 9-11 broad abapical ribs per whorl is known by nine incomplete specimens from FL 11 (P33342 six, P33343 two, P33345 one). Extrapolation

indicates a length of about 49.0 mm for the largest specimen. It will not be possible to name or firmly place this species until complete material is available. Apart from the relatively wide shoulder slope it appears to fit broadly into *Comitas*.

Comitas aldingensis Powell, 1974
(Plate 4, figures 2, 3)

1944: *Comitas (Carinacomitas) aldingensis* Powell; Powell, *Rec. Auckland Inst. Mus.* 3(1): 18-19, Pl. 1, fig. 7.

1969: *Comitas aldingensis* Powell 1944; Powell, *Indo-Pacific Mollusca* 2(10): 292.

Description: Protoconch broadly dome-shaped of 1.75-2.5 smooth whorls with a median carina developing on the first or second whorl, merging into the teleoconch by the gradual development of adult sculpture with either a sub-carinal or a supra-carinal spiral thread or axial ribs developing first. Teleoconch: fusiform, fairly thin; spire about 0.5 height of shell, turretted; whorls medially angulated, convex anteriorly with a concave shoulder slope; suture well-marked, sloping, with a fine subsutural margining thread; body whorl excavate anteriorly into a moderately long, slightly flexed, open, unnotched anterior canal. Axial sculpture: 8-11 (usually 10-11) rounded, slightly opisthocline ribs per whorl, from periphery to suture on spire whorls, fading out on the body whorl just anterior to the periphery; numerous fine growth lines which may be slightly raised on the shoulder. Spiral sculpture: sharp narrow threads which develop flattened tubercles as they override the axials; beside the subsutural thread there are 0-3 fine threads on the shoulder slope and, anterior to the periphery, typically 3 but up to 6 threads on spire whorls and 16-29 (usually 24-28) threads on the body whorl and anterior canal. Aperture: lanceolate, elongated below into the anterior canal; columella slightly twisted; inner lip a glaze on the columella extending to just below the end of the canal; outer lip sharp edged with a well-marked U-shaped posterior sinus on the shoulder, curved forward anteriorly, and straightening down the anterior canal.

Types: Holotype, TM-953, and one paratype, Auckland Museum.

Type Locality: Blanche Point Formation, Blanche Point, Aldinga Bay, S. Australia, Aldingan, late Eocene.

Dimensions:	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	6.8	2.9			
Paratype	7.75	3.0			
P33449	8.1	3.5	4.0	1.75	4.6
(topotypes)	8.3	3.5	4.0	2.0	4.0
	7.3	3.0	4.0	2.0	4.1
	6.9	2.5	3.5	2.0	3.5
	6.8	3.0	3.5	2.0	3.5
P33442	9.0	3.25	4.5	2.5	3.8
(3 of 7)	8.2	3.15	4.1	2.3	3.6
specimens)	8.0	3.0	4.0	2.3	3.8
P33387	12.2	5.0	6.5	2.2	5.0

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Blanche Point Fmn.—Blanche Point (P33449 five topotypes, EA002 one topotype), midway between Blanche Point and Port Willunga (EW001 two specimens, EW002 three fragments); Brown's Creek Clay—FL14 (P33442 seven, P33412 two, EB013 one specimen); FL13 (P33383 one, P33387 one specimen).

Comments: One shell from Brown's Creek (P33387) which is exceptionally large, lacks the subsutural thread and has no sculpture at all on the anterior canal; this latter feature may be due to senescence.

Comitas wynyardensis cudmorei subsp. nov.
(Plate 4, figures 4,5)

Description: Protoconch: 1.75-2.0 whorls, smooth, shining, sub-cylindrical to slightly globose, apex flattened; tip slightly deviated; suture deep; first whorl may slightly overhang second; merges into teleoconch by development of axial sculpture, subsutural cord, and spiral sculpture in that order. Teleoconch: fusiform, fairly thin; spire averaging 0.55-0.56 of shell length, turretted; whorls convex, widest at the bluntly angulate median periphery; shoulder slightly concave; suture well-marked, sloping, with a weak subsutural margining cord at the posterior edge of each whorl, which is strongest on the early whorls; body whorl gently excavate anteriorly into a long, open, slightly flexuous anterior canal, usually with a rounded end. Axial sculpture: 8-13, typically 10-12, rounded,

opisthocline ribs per whorl, about equal to interspaces; from the subsutural cord to the anterior suture on the first 2-3 whorls, thereafter reaching from just posterior to the periphery to the anterior suture, weakening on the body whorl in larger specimens, and not extending to the anterior canal; numerous very fine incised growth lines. Spiral sculpture: close packed fine threads all over the teleoconch whorls, over-riding the axial ribs and extending to the tip of the anterior canal; the threads are very fine on the shoulder, tending to become obsolete on the later whorls of large specimens, stronger and slightly raised anterior to the periphery, up to 50 on the body whorl and 40 on the anterior canal; after about the third whorl the threads may become alternately weaker and stronger. Aperture: lanceolate, elongated below into a large open anterior canal; columella slightly twisted; inner lip a smooth porcellanous glaze on the columella extending to just above the end of the anterior canal; outer lip (none complete) probably sharp edged, with a well-marked posterior sinus with its apex in mid-shoulder occupying the whole shoulder slope, curved gently forward anteriorly, straightening down the anterior canal.

Types: Holotype P42956, Paratype 1 P42957, Paratype 2 P42958, all F. A. Cudmore collection, National Museum of Victoria.

Type Locality: Geological Survey of Victoria locality AW1, Point Flinders, Cape Otway, Victoria, Aire 367097.

Dimensions:	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	27.7	8.6	16.0	2.0	8.0
Paratype 1	27.4	8.4	15.0	1.75	8.0
Paratype 2	22.8	7.5	12.0	1.8	7.0

*Stratigraphic Range:*Aldingan, early Oligocene.

Material and Occurrence: Type locality; types plus numerous topotypes (P42913 15; P42914 98; P42915 2; P42916 3; P42917 one; P42918 7; P42919 13; P42920 one; P42921 4; P42922 7; P42955 one).

Comments: C. wynyardensis cudmorei differs from *C. wynyardensis wynyardensis* Tasmania (Pritchard, 1896) Fossil Bluff, Wynyard, Tasmania early Miocene in its greater number of axial ribs (typically 10-12 compared with typically 9) and in the even, fine, spiral sculpture compared with the regular development of strong threads separated by several finer ones in *C. wynyardensis wynyardensis.* The relationships between the various described Australian late Oligocene *Comitas* spp. are not clear from the material seen by the writer; *C. wynyardensis wynyardensis, C. torquayensis* Powell, 1944 and *C. pseudoclarae* Powell, 1944 have been distinguished by the numbers of axial ribs per whorl, details of the protoconch, and size. Assemblages from individual locations show variations in these characters, but a common feature is that there are fewer axial ribs per whorl than *C. wynyardensis cudmorei* and the spiral sculpture is generally stronger. The writer has so far been unable to recognise *C. crenularoides* (Pritchard, 1896) which is based on imperfect material or *Turris altispira* (May, 1922) which may be a *Comitas.* Both subspecies of *C. wynyardensis* are smaller than the recent Japonic *C. kaderlyi* (Lischke, 1872), the south east Australian *C. murrawolga* (Garrard, 1961) and the South African *C. stolida* (Hinds, 1843), and have a less concave shoulder slope.

C. wynyardensis cudmorei is variable both in shape and in minor details of sculpture such as an occasional tendency for some of the spiral threads to strengthen presaging *C. wynyardensis wynyardensis.* A few specimens (e.g. P42915, P42955) develop markedly angulated whorls but otherwise have the protoconch and sculpture of the subspecies.

Genus ?nov. (allied to **Comitas**)
(Plate 4, figure 6)

Comment: Fossils of three species, up to 9.0 mm long from the Aldingan, late Eocene, resemble *Comitas* but differ in the protoconch having prosocline axial ribs on the last half whorl. In no case is there sufficient material to name them.

*Material:*a. Blanche Point Formation, Blanche Point (EA003 two specimens);
b. FL14 (P33429 one spire, P42912 one spire, EB003 one specimen);
c. FL14 (P42911, one specimen).

Genus **Tholitoma** Finlay and Marwick, 1937

Type species: (o.d.) *T. dolorosa* Finlay and Marwick, 1937.

Tholitoma sp.
(Plate 4, figure 7)

Material: Brown's Creek Clay BC3, FL14, (P33417, one specimen).

Comments: Tholitoma was described from the Paleocene of New Zealand. It also occurs there in the late Eocene (Kaiatan) where probably two species are represented (P. A. Maxwell pers. comm. 1 December 1980), one from GS4872 Port Elizabeth beach near Greymouth Westland, the other from GS11,200 (Kapua Tuffs, Waihao R., South Canterbury). The Brown's Creek fossil has weaker spiral sculpture and somewhat stronger axial sculpture than any of the New Zealand fossils but it has a very similar shape to the species from GS4872. More material is necessary to evaluate these records.

Genus **Makiyamaia** MacNeil, 1960

Type species (o.d.) *Pleurotoma coreanica* Adams and Reeve, 1850.

Diagnosis: Protoconch: paucispiral, smooth, subnaticoid, slightly wider than first post-nuclear whorl. Teleoconch: fusiform (resembling *Turricula*), spire pagodiform with a usually nodulose peripheral angulation. Anterior canal fairly short; posterior sinus narrowly U-shaped, on shoulder slope, nearer to periphery than suture. (Operculum has a medio-lateral nucleus on the columella side.)

Makiyamaia victoriae sp. nov.
(Plate 4, figure 8)

Description: Protoconch: smooth, glossy, naticoid, paucispiral 1.5-1.75 whorls; junction with teleoconch often clear and sometimes exhibits a posterior sinus. Teleoconch: small (up to 9.75 mm), dextral, fusiform, slightly polished; spire just over half length of shell (c. 0.53), slightly turretted; whorls widest at periphery which is at or anterior to mid-whorl; shoulder shallowly concave; suture often inconspicuous, slightly margined by posterior edge of whorl. Axial sculpture: 6-9, usually 8, rounded slightly opisthocline ribs per whorl which start at the periphery where they are strongest and nodulose, just reach the suture on spire whorls, and die out before the anterior canal on the body whorl, on which they tend to fade. Spiral sculpture: numerous slightly undulating spiral lines or very fine flattish cords, very variable in strength from shell to shell and best developed on later whorls (25-39 on body whorl and anterior canal). Aperture pyriform; inner lip a glaze on the columella; outer lip apparently sharp; posterior sinus fairly narrow, U-shaped, on the shoulder, nearer periphery than suture, with lip curving forward anterior to it. Anterior canal open, moderately long, end rounded.

Types: Holotype P42834, Paratype 1 P42835, Paratype 2 P42836, National Museum of Victoria, all coll. T. A. Darragh and H. E. Wilkinson 6 December 1968.

Type Locality: Brown's Creek Clay, FL14.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	8.0	3.0	4.3	1.75	4.8
Paratype 1	8.8	3.4	4.75	1.5	5.2
Paratype 2	8.7	3.5	4.5	1.5	5.0
P33396	9.75	4.0	5.0	1.5	5.25

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Brown's Creek Clay; FL11 (P42838 one); FL13 (P42837 one, P33396 one); FL14 (types plus topotypes – P33434 thirteen, EB004 3, P33414 one; P42839 3, P42840 one). Blanche Point Fmn, Blanche Point (EA004 one).

Comments: Makiyamaia MacNeil, 1960 has been used for four species and two subspecies of Turriculinid turrids from the late Eocene to Recent of the Japonic region, with one species (*M. subdeclevis* (Yokoyama, 1926)) extending to the South China sea (Powell, 1969: 307-310). All these are medium sized shells, 18-34 mm long, but size alone is no criterion for rejecting a generic placement, nor is geographical separation; for instance the Australian Oligocene-Miocene genus *Optoturris* has been recorded from the Japanese Lower Pliocene (*O. kyushuensis* Shuto, 1961). In protoconch, teleoconch shape, sculpture, sinus, and anterior canal this new Australian species appears to fit best into *Makiyamaia*, but the margination of the suture is not typical.

P42838 from FL11 may be conspecific but

has two protoconch whorls which are (probably pathologically) askew in relation to the teleoconch; the spiral sculpture is very weak, so is the axial sculpture which is reduced to a peripheral keel on the last two whorls. The one congeneric specimen available to the writer from Blanche Point (EA004) differs from Brown's Creek Clay material in having more axials (11-12 per whorl) and relatively strong spiral sculpture, but without more Blanche Point material these differences cannot be evaluated.

Genus **Apiotoma** Cossmann, 1889

Type species (o.d.) *Pleurotoma pirulata* Deshayes, 1834.

Diagnosis: Shell attenuate-fusiform; spire tall of rapidly increasing whorls; anterior canal long, unnotched; spiral sculpture usually dominant; shoulder area with posterior sinus, more or less sunken; protoconch smooth, globose to narrowly conic, 1½-2½ whorls with small assymetric tip.

Comments: In addition to *A. bassi* Pritchard, 1904 from AW1 three species from the Brown's Creek Clay appear to belong to *Apiotoma*, but the material for two of these, both from FL11 (a. P33353 (Pl. 4, fig. 13); b. P33356 (Pl. 4, fig. 14, 15)) is insufficient for full identification.

Apiotoma? wilkinsoni sp. nov.
(Plate 4, figures 9-11)

Description: Shell fusiform, anterior canal long and nearly straight. Protoconch: 1.7-2.0 whorls, smooth; first whorl rounded, second sub-cylindrical; tip deviated and immersed; merges into teleoconch. Teleoconch: fusiform, spire slightly less than half height of shell; whorls shallowly concave above a rounded median periphery, gently convex below; suture flatly marginated by posterior edge of whorls. Axial sculpture: very faint axial growth lines. Spiral sculpture: very numerous low cords extending over whole whorl and to end of anterior canal, usually 8 increasing to 13-15 on spire whorls; more numerous above than below the periphery and slightly more prominent anterior to it; 70 plus on body whorl and anterior canal.

Aperture: lanceolate; columella straight; inner lip a glaze on the columella; outer lip (not complete) evidently curved gently forward below periphery; posterior sinus deep, narrow, in mid-shoulder.

Types: Holotype P42832, Paratype 1 P42833 both coll. T. A. Darragh and H. E. Wilkinson 6 December 1968, Paratype 2 P33403 coll. T. A. Darragh 20 November 1970, National Museum of Victoria.

Type Locality: Brown's Creek Clay, FL14.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype (apex missing)	35.0 (+)	12.0	15.0 (+)	—	5.7 preserved
Paratype 1 (incomplete anteriorly)	20.0	c.8.0	14.0	c.1.7	c.6.0(+)
Paratype 2 (part of outer lip lost)	29.8	9.8	14.0	c.1.7	6.5

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Types plus 10 topotypes (P33436 5, P33410 3, EB001 2); FL13 (P33392 one).

Comments: Although every available specimen of this fossil is imperfect there is enough material to reconstruct its appearance fairly fully. *A?. wilkinsoni* seems to be related to *Turris janjukiensis* Chapple, 1934 (placed in *Apiotoma* by Powell, 1944:20) and also possibly to *Pleurotoma salebrosa* Harris, 1897 (placed in *Comitas* by Powell, 1944:18 though it has no axial sculpture). The generic placement is tentative; the teleoconch of *A?. wilkinsoni* resembles *Turricula* in many respects.

Apiotoma bassi Pritchard, 1904
(Plate 4, figure 12)

1904 *Apiotoma bassi* Pritchard; Pritchard, *Proc. R. Soc. Vict.* 17:328, Pl. 19, fig. 11.

1914 *Apiotoma bassi* Pritchard; Chapman, *Mem. natn Mus. Vic.* 5:19

1944 *Apiotoma bassi* Pritchard; Powell, *Rec. Auckland Inst. Mus.* 3(1):20

1969 *Apiotoma bassi* Pritchard; Powell, *Indo-Pacific Mollusca* 2(10):247.

Description: Protoconch mammilate, of 1.6-1.8 smooth, rounded whorls; tip deviated and immersed; suture well-defined. Teleoconch: elongately fusiform, moderately thin; spire turretted, about 0.45 length of shell; whorls develop a variable, usually well-marked, postero-medial peripheral angulation, a shallowly concave shoulder slope, and an almost straight-sided anterior portion narrowing slightly to the suture which is inclined, well-defined, and margined by a low subsutural fold on later whorls; body whorl slightly convex, long, narrow, tapering with a slight excavation into the long, almost straight, open, unnotched anterior canal. Axial sculpture: low variable opisthocline ribs from periphery rarely reaching the anterior suture, and often reduced to nodulations of the peripheral angulation; they are strongest on the second and third whorls where they number 14-19 per whorl, and may persist for up to seven whorls or be completely obsolete; numerous very fine growth lines interrupt the spiral sculpture. Spiral sculpture: very numerous fine spiral threads of variable width but even strength cover the teleoconch, up to 100-105 on the body whorl and anterior canal. Aperture: narrowly lanceolate, tapering into the anterior canal; inner lip a dull glaze on the smooth tapering columella which is almost straight or twisted anteriorly; outer lip curved back into a well-marked U-shaped posterior sinus occupying the shoulder slope, produced gently forward below the periphery and straightening, with a very shallow concavity, down the anterior canal.

Types: Holotype, MUGD 1825 Melbourne University Geology Department.

Type Locality: "the clays of the Cape Otway section near Point Flinders" (Pritchard, 1904:329) = Glen Aire Clay, GSV loc AW1.

Dimensions: "Average specimens have length of about 33 mm by a breadth of 10 or 11 mm; length of aperture and canal 20 mm; greatest width of aperture about 3.5 mm. Specimens on the large side range from 45-50 mm in length by a breadth of about 13 mm, while small specimens range about 24 mm in length by 8 mm breadth." (Pritchard, 1904:329).

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
P42897	38.5	11.0 (+)	17.25	1.75	6.5
	35.5	10.0	16.5	c.1.7	7.0
	35.5	9.25	18.0	c.1.7	7.0
	25.3	7.2	11.5	c.1.8	5.5
	14.0	4.0	6.8	c.1.7	4.75

Stratigraphic Range: Upper Aldingan, early Oligocene.

Material and Occurrence: Type Locality (P42897, P42898, 159 topotypes coll. T. A. Darragh, T. Hughes, 1 December 1972).

Comments: *A. bassi*, the Janjukian (late Oligocene) *A. pritchardi* Powell, 1944, and what is probably another species from the Batesfordian (early Miocene) (FL43 Kennedy's Creek) form a series that is very close in shape to the type species of *Apiotoma.*

Genus **Insolentia** Finlay, 1926

Type species (o.d.) *Pleurotoma pareoraensis* Suter, 1907

?**Insolentia** sp.
(Plate 4, figures 16, 17)

Material and Occurrence: Brown's Creek Clay; FL13 (P33385, one specimen); FL14 (P33400 2, P33420 one, EB002 one, P33416 apex/spire only).

Comments: This moderately large 'turriculinid', probably 30.0(+) mm long, with axial sculpture on the spire only, is only represented by incomplete specimens. The only protoconch available (P33416) is turbinate, dome-shaped above, of about 3 smooth whorls, tip not deviated, merging into the teleoconch on which spiral sculpture appears before the axials; however it is associated with a few spire whorls only. If P33416 does come from this species, then the genus is not *Comitas* or *Apiotoma.* The shape of the teleoconch in the other specimens resembles *Insolentia* (Eocene-Miocene New Zealand, late Oligocene Australia, Powell, 1966), and *Typhlosyrinx* Thiele, 1925, not recorded as a fossil.

Genus **Marshallaria** Finlay and Marwick, 1937

Type species (o.d.) *Verconella spiralis* Allan, 1926.

Diagnosis: Shell biconic-fusiform (bucciniform), spire turretted with strong peripheral angulation, and a capacious body whorl, gradually contracted to a moderately long, unnotched, anterior canal. Adult sculpture fairly prominent axials overridden by numerous spiral cords and threads. Protoconch dome-shaped, of about 3½ whorls, the first one and a half smooth, the remainder with strong spiral cords. Sinus regularly shallowly concave, occupying the shoulder slope.

Marshallaria otwayensis sp. nov.
(Plate 5, figures 3, 4)

Description: Protoconch: 2.9-3.3 whorls, dome-shaped, tip exsert, whorls rounded, initially smooth, 5 gradually strengthening spiral cords on last 0.3-0.9 of a whorl. Teleoconch: thin, buccinoid; spire about half height of shell; suture unmargined; shoulder slightly concave occupying about a third of whorl height; periphery well marked but rounded; body whorl large, tapering below into anterior canal. Axial sculpture: numerous basically opisthocline ribs, narrower than interspaces, from just above periphery to suture on spire whorls, dying out above anterior canal on body whorl, 17-23, mostly 19-21, per whorl; numerous fine, thread-like axial growth lines. Spiral sculpture overrides axials: very numerous spiral threads, about every tenth one stronger than those intervening, present over whole teleoconch. Aperture pyriform; open below into a short, round-ended anterior canal, inclined slightly to left; inner lip a glaze on columella which is slightly twisted, with a slight oblique fold near the base; outer lip curved gently forward below periphery. Posterior sinus (indicated by growth lines) shallow, on shoulder slope, with a mid-shoulder centre.

Types: Holotype P42844, Paratype 1 P42845 both F. A. Cudmore collection, Paratype 2 P42846 coll. T. A. Darragh and T. Hughes 1 December 1972, National Museum of Victoria.

Type Locality: Glen Aire Clay, GSV locality AW1.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	19.5	9.5	8.5	3.0	4.25
Paratype 1	15.0	7.8	7.0	2.9	4.0
Paratype 2	33.2	10.5	c.15.0	3.0	4.75 (traces to 5.0)

Stratigraphic Range: Upper Aldingan, early Oligocene.

Material and Occurrence: Type locality; types plus 17 topotypes (P33333 5, P33335 9, P42935 one, P42936 two).

Comments: This species is not uncommon at AW1, but its fragility has resulted in nearly all available specimens being damaged. *Marshallaria otwayensis* clearly belongs to a group of bucciniform turrids (*Marshallena* Allen, 1927:291, *Marshallaria*, *Austrotoma* Finlay, 1924: *Belophos Cossmann*, 1901:162, *Liratomina* Powell, 1942: *Belotomina* Powell 1942, mostly characteristic of the New Zealand and Australian Tertiary, though Powell (1966, 1969) has also included several recent Indo-Pacific species in *Marshallena. M. otwayensis* lacks the subsutural margining fold, the notching of the anterior canal and the ridge-margined fasciole of *Austrotoma*; the protoconch has 3, not the 4-5 whorls of *Austrotoma* and it is not smooth like that of *Marshallena*; the teleoconch has a gently concave shoulder slope, not the sloping shoulder slope of *Marshallena. Belophos* has a notched anterior canal, a much thicker shell, and a 4-5 whorled, not a 3-whorled, protoconch. *Belatomina* and *Liratomina* have a very different teleoconch and a paucispiral protoconch. Since the only difference between *Marshallaria* as diagnosed and *M. otwayensis* seems to be the weaker and later development of spiral sculpture on the protoconch, the latter seems best placed in this genus. *Marshallaria* has not been previously recorded outside the Paleocene to late Oligocene of New Zealand.

Genus **Paramarshallena** gen. nov.

Type species: Paramarshallena propebelloides sp. nov.

Diagnosis: Shell buccinoid; spire turretted; whorls angulate at about one-third whorl height, weakly margined posteriorly; spire about half height of shell. Body whorl

capacious, tapering gently below into an open unnotched anterior canal. Posterior sinus on shoulder curved gently, very shallow, apex at mid-shoulder. Protoconch paucispiral, dome-shaped, 1.5-2.0 whorls, tip partly immersed, first whorl smooth, second developing orthocline axial ribs before merging into teleoconch. Teleoconch thin; sculpture dominated by thin, opisthocline, axial ribs which extend above periphery to suture on spire whorls, but do not extend to anterior canal on body whorl. Aperture: narrow, ovate; inner lip a glaze on columella which is nearly straight and inclined slightly to left; outer lip thin, sharp, curved back in shallow sinus on shoulder, and produced gently forward below.

Comments: The relationships of this small bucciniform turrid genus are uncertain; it resembles two different groups of which the first is the genus *Marshallena* Allan, 1926. *Paramarshallena* resembles *Marshallena* in the general form and sculpture of the teleoconch, but differs from *Marshallena* in having a paucispiral protoconch, a weak subsutural margining fold, and more strongly opisthocline sculpture.

The second group of genera consists of:

1. the circum-arctic *Propebela* Iredale, 1918 which is about the same size as *Paramarshallena* (c.f. *P. exquisita* Bartsch, 1941—Powell 1966, Pl 19, fig. 2), but the paucispiral protoconch of *Propebela* develops carinae and fine axial threads; *Propebela*'s shoulder is more nearly flat, and the axial sculpture is orthocline not basically opisthocline;
2. the Japonic *Nodotoma* Bartsch, 1941, a poorly defined genus;
3. the Antarctic *Belalora* Powell, 1951 which has a different protoconch;
4. the Antarctic *Lorabela* Powell, 1951 in which the protoconch is described as narrowly papillate, and the posterior sinus deep and rounded.

None of this second group develops the subsutural margining of *Paramarshallena*. Until further evidence emerges to enable its inclusion in another genus it appears best to isolate *P. propebelloides* in a genus of its own.

Paramarshallena propebelloides sp. nov.
(Plate 5, figure 5)

Description: protoconch: dome-shaped, tip partly immersed, and oblique; 1.5-2.0 whorls, the first smooth the second developing up to 10 orthocline to slightly prosocline axial ribs before merging into the teleoconch. Teleoconch: buccinoid; spire turretted about ½ height of shell, post-medially angulated at about one-third whorl height below suture; suture oblique with a weak margining fold on posterior edge of whorls. Body whorl pyriform, large, tapering gently below into short, open, unnotched anterior canal. Axial sculpture: narrow, sharp, spaced, axial ribs, prosocline and slightly curved on shoulder, slightly nodulose on periphery, opisthocline below periphery, from suture to suture on spire whorls, dying out on body whorl above anterior canal, 10 increasing to up to 16 per whorl, tending to weaken after about 4 whorls; numerous close-set growth lines. Spiral sculpture: very fine spiral threads, up to 10-12 below shoulder of spire whorls, and weak posterior to shoulder, 30-35 on body whorl and anterior canal; variable in strength and may be obsolete. Aperture: narrowly ovate, angulated posteriorly; inner lip a glaze on the nearly straight columella which tapers off at the end of the anterior canal, and on the curve of the parietal region; outer lip (as preserved) sharp, thin, with a shallow sinus on shoulder, and curved forward below the periphery.

Types: Holotype P42847, Paratype 1 P42848 both coll. T. A. Darragh 24 February 1971; Paratype 2 P33375 coll. T. A. Darragh 20 November 1970, National Museum of Victoria.

Type Locality: Brown's Creek Clay, BC1, FL11.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	13.1	6.2	6.3	c.1.75	4.5
Paratype 1	8.6	4.9	4.5	1.5	3.5
Paratype 2	11.4	5.8	5.2	2.0	4.0
P33398	13.5	6.5	7.0	c.1.75	4.2

Stratigraphic Range: BC1-BC3, Aldingan, Late Eocene.

Material and Occurrence: Type locality, types plus 14 topotypes (P33359 9, P33364 5); FL13 (P33391 one, P33398 one).

Genus **Cochlespira** Conrad, 1865

Type species (by virtual monotypy) *Pleurotoma cristata* Conrad, 1847.

Diagnosis: Shell elongate-fusiform with a tall pagodiform spire, and a long body whorl gradually tapered to a long unnotched anterior canal. Protoconch subglobose or subcylindrical, of two smooth whorls, sometimes angulate towards its termination. Adult whorls with a more or less median peripheral carina, flange-like, either serrated or coronated by posteriorly directed spinose processes. Suture may be gemmately submarginated. Shoulder slope concave, smooth or with spiral sculpture. Anterior to the periphery, whorls may vary from smooth to densely spirally sculptured, and may have a second keel above the start of the anterior canal. Sinus on the shoulder slope, broadly arcuate or restricted to above a median lamella.

Cochlespira semiplana (Powell, 1944)
(Plate 5, figure 6)

1944 *Coronasyrinx semiplana* Powell. *Rec. Auckland Inst. Mus.* 3(1):22 Pl. 1, Fig. 2.
1969 *Cochlespira semiplana* (Powell, 1944); Powell, *Indo-Pacific Mollusca* 2(10): 402.

Description: Protoconch: globose to subglobose, tip deviated, of 1.5-2.0 smooth whorls, the second developing a median or submedian smooth keel; merges with the teleoconch. Teleoconch: fusiform, thin, spire pagodiform; whorls with a prominent anteromedian flanged peripheral keel and a long concave shoulder slope; suture indistinct, margined above and below by a fine thread; body whorl with a second keel anterior to the peripheral keel, excavate anteriorly into a long, nearly straight, anterior canal. Axial sculpture: 18-26 posteriorly directed denticulations per whorl on the peripheral keel; anterior keel on body whorl smooth or finely denticulate; very faint growth lines. Spiral sculpture: beside the peripheral keel, fine sub-sutural and supra-sutural margining threads develop which may be smooth or finely gemmulate; the body whorl may develop 3-4 weak spiral threads between the peripheral and anterior keels; 17-21 smooth to finely gemmulate threads anterior to the second keel on the body whorl, extending down the anterior canal. Aperture: apparently lanceolate (matrix filled and fractured); outer lip with a U-shaped posterior sinus in the smooth shoulder area below the subsutural thread, and curved forward anterior to the periphery.

Type: Holotype, TM956, Auckland Institute (confirmed W. O. Cernohorsky in lit. 9 Feb 1978; TM957, Powell, 1969:402, is an error).

Type Locality: Aldinga lower beds (= Blanche Point Fmn, Blanche Point, Aldinga, S.A.).

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	9.6	3.9	–	1.5	4.0
P33446	11.0	4.8	5.5	2.0	5.0
EA001	11.0 (+)	–	–	–	(incomplete)
P33445	10.0	4.5	5.0	2.0	c.4.0 (incomplete)

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Type Locality (P33446 1, EA001 1); Brown's Creek Clay FL11 (P33445 1).

Comments: Although much of the material is damaged this is clearly a *Cochlespira*. *C. venusta* (Powell, 1944), late Oligocene-Middle Miocene south east Australia has more numerous, but more conspicuously gemmulate, finer spiral threads, a much weaker anterior keel on the body whorl, and a more flattened protoconch on which the median keel develops on the first whorl.

Genus **Turrinosyrinx** Hickman, 1976

Type species (o.d.) *Turris packardi* Weaver, 1916

Diagnosis: Protoconch: paucispiral, smooth. Teleoconch: fusiform; spire pagodiform with a prominent peripheral carina; body whorl narrowing rapidly below into a moderately long, open, round-ended, anterior canal. Posterior sinus usually shallow, V-shaped, apex immediately posterior to or on the peripheral carina. Spiral sculpture more prominent than axial sculpture which is weakly developed.

Turrinosyrinx denticulata sp. nov.
(Plate 5, figure 7)

Description: Protoconch: paucispiral, 1.5-1.75 whorls, tip deviated and slightly immersed; first whorl globose, the second developing a rounded median angulation, and, usually 3-6, orthocline axials which show traces of the posterior sinus just before the well-defined start of the teleoconch. Teleoconch: fusiform; spire pagodiform, slightly under ½ height of shell; whorls with a denticulate, flanged, median keel and a long, nearly straight, shoulder slope. Body whorl slightly ventricose just anterior to the peripheral keel, then narrows rapidly into a long open anterior canal. Suture well-defined, unmargined. Axial sculpture: numerous fine axial growth lines; 20-30 denticulations on the peripheral keel. Spiral sculpture: very weak spiral cords with linear interspaces, usually only present, if at all, on the body whorl, and only developed on the shoulder as a weak trace; Paratype 1 has three spirals on the peripheral keel on the penultimate and body whorls, five on the anterior part of the penultimate whorl, and 27 on the body whorl and anterior canal. Aperture: elongately wedge-shaped; outer lip (not fully preserved) probably thin, deeply cut by a V-shaped sinus with its apex on the peripheral keel, and curved forward anteriorly; inner lip a glaze on the columella, which is slightly sigmoidally curved, and tapers to a point just above the end of the anterior canal. Anterior canal open, unnotched, long, inclined slightly to the left.

Types: Holotype P33354 coll. T. A. Darragh 24 February 1971; Paratype 1 P33361, Paratype 2 P42850 both coll. T. A. Darragh 18 October 1971, National Museum of Victoria.

Type Locality: Brown's Creek Clay, BC1, FL11.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	10.5	4.8	5.0	1.5	4.0
Paratype 1	9.4	4.1	4.3	1.5	4.0
Paratype 2	9.8	3.7	4.5	1.5	c.4.0 (slightly broken)
P42849	9.0	4.2	(5.0)	c.2.0	c.4.0 (slightly broken)

Stratigraphic Range: Aldingan, late Eocene-early Oligocene.

Material and Occurrence: Type locality (Types plus P42849 one); FL13 (P33390 one); GSV loc. AW1 (P42929 one).

Comments: This species has the essential generic characters of *Turrinosyrinx* which was erected by Hickman (1976) for a group of species of cochlespirine form from the early Oligocene of Oregon USA. It differs from them in having a denticulate flanged peripheral keel and in having the apex of the relatively deep anal sinus on the centre of the peripheral keel and not posterior to it. As *T. denticulata* is the stratigraphically earliest species so far assigned to *Turrinosyrinx* this latter feature is consistent with the trend demonstrated by Hickman (1976: 76) for the apex of the anal sinus to migrate posteriorly in successively later species. *T. denticulata* also provides a link additional to those reported by Hickman (*op. cit.*) between the Paleogene Turridae of the north west Pacific and the Australasian region.

Genus **Johannaia** gen. nov.

Type species: J. darraghi sp. nov.

Diagnosis: Protoconch paucispiral, smooth; first whorl rounded, tip deviated; second subcylindrical, with 3-5 vertical axial ribs in last ¼ whorl. Teleoconch elongate-fusiform, spire tall anterior canal short; whorls medially angulated. Axial sculpture long flexuous ribs, not nodulated at periphery, more or less continuous from whorl to whorl. Posterior sinus shallow occupying all of shoulder slope, apex just above the periphery. Aperture lanceolate.

Comments: Johannaia seems to have no close relatives in either the Australian or the New Zealand Tertiary, nor is it like any genus recognized by Powell (1966, 1969) as falling within the sub-family Cochlespirinae with which it seems to have features in common. On the other hand the style of sinus and axial sculpture approach *Eopleurotoma* Cossmann, 1889 but it differs from *Eopleurotoma* in its larger paucispiral protoconch with a few axial ribs on the last ¼ whorl, and in the strong peripheral angulation of the protoconch.

Johannaia darraghi sp. nov.
(Plate 5, figures 1, 2)

Description: Protoconch: paucispiral, two whorls, first smooth, rounded, tip deviated, second subcylindrical, smooth apart from 3-5 vertical axial ribs in the last quarter whorl. Teleoconch: narrow, fusiform; surface rather smooth and slightly polished; spire just over ¼ height of shell; whorls medially angulated, widest at periphery with a long nearly straight shoulder slope. Body whorl tapered rapidly below to a moderately long, round-ended, anterior canal, curved slightly to the right. Axial sculpture: low, rounded ribs, 7-12 per whorl, prosocline adapically, angulated at the periphery and opisthocline abapically, from the posterior suture to the anterior suture, more or less in alignment from whorl to whorl and dying out above the anterior canal; many fine growth lines on shoulder. Spiral sculpture: numerous striae usually present, extending to the end of the anterior canal; up to 22 on spire whorls and c.30 on body whorl and canal. Aperture lanceolate, angulated posteriorly, with a short, open, square-ended, slightly inclined anterior canal; inner lip a glaze on the columella; outer lip curved slightly forward below periphery; posterior sinus shallow, occupying all of shoulder slope, apex near periphery, not confluent with the axial ribs.

Types: Holotype P42841, Paratype 1 P42842, Paratype 2 P42843, all coll. T. A. Darragh 24 February 1971, National Museum of Victoria.

Type Locality: Brown's Creek Clay, BC1 FL11.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	15.3	4.6	8.4	2.0	6.0
Paratype 1	16.0	4.25	8.5	2.0	6.0
Paratype 2	18.8	5.1	10.5	2.0	6.2
P33347	15.0	4.0	8.5	2.0	6.25

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Type locality, types plus nine topotypes (P33351 3, P33367 3, P33349 2, P33347 one).

Sub-family TURRINAE Swainson, 1840

Genus **Gemmula** Weinkauff, 1875

Type species (s.d. Cossmann, 1896) *Pleurotoma gemmata* Reeve, 1843 = *Gemmula hindsiana* Berry, 1958.

Diagnosis: Shell elongate-fusiform, spire tall, anterior canal long, straight, unnotched. Protoconch tall, conical, polygyrate, axially costate. Adult sculpture is spiral keels and cords, with a gemmulated, often double, peripheral keel. Posterior sinus deep and narrow, on the peripheral keel. usually rather large, 24-88 mm.

Subgenus **Clavogemmula** subgen. nov.

Type species: Gemmula (Clavogemmula) prima sp. nov.

Diagnosis: Shell fusiform, spire tall, anterior canal short, twisted slightly. Protoconch: conoidal, polygyrate, 5.5-6.0 whorls, the early whorls smooth, the last whorl or so axially costate. Teleoconch has a dominant sculpture of spiral threads and cords; the posterior sinus is deep, V-shaped, narrowed near the periphery, with its apex on the peripheral cord which is heavily gemmate on the first teleoconch whorl. The gemmules weaken after 2-3 whorls to become at most barely discernible thickenings of the peripheral cord.

Comments: Clavogemmula differs from *Gemmula* s.s. by the mostly smooth protoconch, the short, twisted (not long and straight) anterior canal, and the rapid degeneration of the axial gemmules. *Unedogemmula* MacNeil, 1960 also has degenerating peripheral gemmulation and a similar protoconch to *Clavogemmula*, but has a long straight anterior canal. *Ptychosyrinx* Thiele, 1925 has a teleoconch of similar form to *Clavogemmula*, but with a broadly V-shaped not very deep sinus and persistent peripheral gemmules; the protoconch of the species ascribed to *Ptychosyrinx* by Powell (1964) is not known except for the type species, *P. bisinuata* (Martens, 1901), where it is narrowly conic, polygyrate, and closely axially ribbed. *Clavogemmula* does not show any signs of the spout-like projection of the outer lip anterior to the sinus which is intermittently present in *P. bisinuata* and *P. timorensis teschi* (Powell, 1964).

Clavogemmula is clearly very closely related to the widespread and geologically persistent group of Turrinae with a polygyrate protoconch and gemmate peripheral keel of which *Gemmula* is the typical genus. In its claviform appearance with a long spire and short anterior canal it also resembles certain later Australian Tertiary Turrinae (*Veruturris* spp.) in which there may also be traces of peripheral gemmulation and an initially smooth, later axially costate protoconch which is, however, paucispiral with a large immersed tip.

Gemmula (Clavogemmula) prima sp. nov.
(Plate 5, figures 9, 10)

Description: Protoconch: polygyrate, 5.0-5.7 whorls, tip exposed, not deviated, conoidal, the first 4.5 or so whorls smooth, the last 1.1-1.3 whorls with 20-24 gently curved orthocline axial ribs; the junction with the teleoconch is well defined by the initiation of a shoulder sulcus and a subsutural margining cord. Teleoconch: fusiform; spire long, pointed, about two-thirds height of shell; whorls medially angulated, widest at the periphery, shoulder concave, anterior portion almost straight; body whorl short, excavated anteriorly into a short and twisted anterior canal. Axial sculpture: 15-20 gemmulations per whorl centred on the periphery, strong and elongate on the first 1-2 whorls, becoming progressively weaker by the fourth and later whorls; numerous close, very fine growth lines. Spiral sculpture is narrow threads and the peripheral keel; one fairly prominent thread submargins the suture, with a gradually increasing number of weak threads, usually 2-3 but up to 7, on the shoulder; the peripheral keel is either simple or double threaded (to produce a double row of weak gemmulations); there is a gradually increasing number, usually 1-3 but again up to 7, of threads anterior to the periphery on spire whorls, 7-12 threads of varying strength on the anterior of the body whorl (depending on age) and 14-17 undulose threads on the anterior canal. Aperture: broadly lanceolate; outer lip probably sharp (all fractured) directed sharply back on shoulder to a narrow posterior sinus with its apex on the peripheral keel and curved gently forward below the posterior sinus; inner lip smooth, porcellanous, slightly incised into body whorl; columella slightly twisted and attenuating below into a short, straight ended anterior canal, twisted slightly to the left.

Types: Holotype P33350, Paratype 1 P42851, Paratype 2 P42852, all collected T. A. Darragh 24 February 1971, National Museum of Victoria.

Type Locality: Brown's Creek Clay, BC1, FL11.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	13.4	5.0	8.75	4 preserved	5.75
Paratype 1	8.0	3.2	4.5	5.0	3.5
Paratype 2	7.8	3.0	4.5	5.5	3.3
P42853	10.5	4.1	7.5+	1.5 preserved	5.0
P42853	7.0	2.9	4.0	5.7	3.0

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Type locality; types plus P42853 (two topotypes).

Comments: The salient points of this species are those of the genus. The spiral sculpture is the major variable.

Genus **Veruturris** Powell, 1944
Veruturris sp.
(Plate 5, figure 8)

Stratigraphic Range: Aldingan, late Eocene

Material and Occurrence: Brown's Creek Clay, FL13 (P33393 one); FL14 (P33433).

Comments: This is the earliest member of the *Veruturris* line so far discovered. Compared with other *Veruturris* species it has a relatively globose protoconch, and short anterior canal, and the sculpture is simple with the spiral cords not tending to be bi-partite.

Sub-family BORSONIINAE Bellardi, 1875
Genus **Cordieria** Rouault, 1848

Type species (s.d. Cossmann, 1896) *Cordieria iberica* Rouault, 1850.

Diagnosis: Protoconch small, 1½-2 smooth whorls. Teleoconch ovate-fusiform with a tall conical spire of weakly convex whorls; body whorl elongate-ovate, hardly excavated on merging into a short unnotched anterior canal;

axial sculpture broad axial folds; spiral sculpture rather dense spiral lirations. Outer lip thin edged, with a shallowly arcuate subsutural sinus; two oblique median plaits on the columella.

?Cordieria sp. a.
(Plate 5, figure 11)

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: BC1, FL11 (P33348 5, P33373 1).

Comments: Though this small species (largest specimen L. 9.1 mm, B. 3.8 mm) has a better defined anterior canal than is perhaps typical and a very weak posterior sinus, it, the BC3 fossil referred to below and ultimately *Borsonia protensa* Tate, 1898 relate to a series of New Zealand fossils placed in *Cordieria* of which the writer has seen *C. rudis* (Hutton, 1885), *C. verrucosa* (Finlay, 1930) and *C. haasti* (Finlay, 1930).

Cordieria protensa (Tate, 1898)
(Plate 5, figures 14-16)

1898 *Borsonia protensa* Tate, *Proc. R. Soc. N.S.W.* 31:394, Pl. 19, fig. 6.
1898 *Borsonia polycesta* Tate, *Ibid* 31:395, Pl. 19, fig. 2.
1898 *Borsonia otwayensis* Tate, *Ibid* 31:394, Pl. 19, fig. 4.
1944 *Borsonia protensa* Tate; Powell, *Rec. Auckland Inst. Mus.* 3(1):42.
1944 *Borsonia polycesta* Tate; Powell, *Ibid* 3(1):42.
1944 *Borsonia otwayensis* Tate; Powell, *Ibid* 3(1):42.

Description: Protoconch: paucispiral, 1.75-2.2.smooth whorls, subcylindrical, merging into teleoconch; top dome-shaped; tip deviated and inrolled; suture distinct. Teleoconch: fusiform; spire acute, slightly more than ½ height of shell; whorls, especially the early ones, usually gently rounded, but a few specimens develop a weak (*polycesta*) or even a well-marked peripheral angulation (*otwayensis*) producing a shoulder slope extending over the posterior ½ or third of the whorl; upper whorls slightly polished; body whorl tapers gently below to a square-ended, moderately long anterior canal curved slightly to the left; suture distinct, margined on upper whorls. Axial sculpture: spaced, rounded, slightly opisthocline axial ribs best developed on the upper whorls where they help produce a narrow concave shoulder and strongest below periphery; the ribs may persist for up to 8 whorls or may start to fade after 5 and become obsolete after 6 or so whorls; the ribs number 9-12 on the first whorl, 7-11 on the next two or three, and then become fewer and broader; numerous very fine axial growth lines. Spiral sculpture: very fine very numerous spiral threads, overriding the axials, from suture to suture on spire whorls and extending to the end of the anterior canal on the body whorl. Aperture narrowly lanceolate, open anteriorly into a square-ended anterior canal slightly shorter than, or about equal in length to the rest of the body whorl; outer lip sharp, curved backwards into a gentle sinus which can be traced as persistent back to the first teleoconch whorl and produced forwards in a gentle curve anteriorly, straightening down the anterior canal; inner lip a moderately broad glaze on the columellar and parietal region, extending to near the tip of the anterior canal and polished in well-preserved specimens; two oblique lamellae terminate at the top of the columella just below its junction with the parietal lip and continue internally as strong parallel lamellae for at least 4-5 whorls towards the apex. (In specimens with a complete outer lip these lamellae appear inconspicuous as they merge into the columella at the aperture.)

Types: South Australian Museum: Holotype T340D, Holotype of *Borsonia polycesta* T327C, Holotype of *B. otwayensis* T320D.

Type Locality: Glen Aire Clay, GSV locality AW1, Pt. Flinders, near Cape Otway, Vic. (given as 'Eocene, Cape Otway, Victoria' Tate, 1898).

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	35.5	8.6		(1.5)	(8.0)
T327C	13.6	4.8			
T320D	20.8	7.0			(7.0)
P42895	40.25	11.4	21.8	?1.5 (eroded)	8.1
P42895	35.25	12.5	16.3	1.75	8.3
P42895	31.9	10.3	16.25	?1.5 (eroded)	c.8.0
P42895	21.0	6.2	11.0	1.8	6.4
P42895	18.0	6.0	9.5	1.75	6.25
P42895	8.5	3.3	4.5	1.8	4.5

Stratigraphic Range: Upper Aldingan, early Oligocene.

Material and Occurrence: P42895, 65 topotypes coll. T. A. Darragh, T. Hughes, 25.11.1975.

Comments: Like the other abundant Glen Aire Clay turrids *Comitas wynyardensis cudmorei* and *Apiotoma bassi, Cordieria protensa* is very variable, but the protoconch, early whorls, and the rate of growth are reasonably constant characters and indicate that only one species is involved. Tate's three species are based on fairly large typical specimens (*protensa*), specimens with heavily angulated whorls (*otwayensis*), and a small specimen (*polycesta*). Of Tate's three names *protensa* takes page priority. *C. protensa* has been placed in *Borsonia* in the past, as its large size and prominent anterior canal are characters often held to be characteristic of *Borsonia*. However the BC3 material (see below) indicates that it probably developed from a *Cordieria*-like source similar to the late Eocene New Zealand fossil species also assigned to *Cordieria*, *C. rudis* (Hutton, 1895), *C. haasti* (Finlay, 1930), *C. verrucosa* (Finlay, 1930) and *C. huttoni* (Finlay, 1930). The assignment of these Borsoniid turrids with two columellar lamellae from Australia and New Zealand into two different genera is an artifact and tends to obscure their relationships.

Cordieria sp. cf. **protensa** (Tate, 1898)
(Plate 5, figure 12)

Description: Protoconch: c.1.5 whorls, smooth, semi-cylindrical, first whorl dome-shaped, tip slightly deviated, overhanging second whorl. Teleoconch: biconic-fusiform, spire about three-fifths height of shell; whorls nearly straight sided with a slightly concave shoulder and the periphery at about ¼ of the whorl height anterior to the suture; body whorl rounded, narrowed gently below into a short, open, anterior canal. Axial sculpture: broad, rounded, nearly orthocline ribs about equal to interspaces, 8-11 per whorl, starting just below the subsutural cord on the two upper whorls and at the periphery on later whorls, extending to the suture anteriorly on spire whorls, noticeably fewer and weaker after about 5 whorls, and dying out above the anterior canal on the body whorl; numerous faint axial growth lines becoming fold-like on the end of the anterior canal. Spiral sculpture: a double subsutural cord margins the posterior edge of each whorl; numerous fine spiral threads override the axials, from suture to suture on the spire whorls and extending almost to the end of the anterior canal, about 5 on the first whorl increasing to 19-20 on the 5th, 40-50 on body whorl, and 9-10 on anterior canal. Aperture narrow, lanceolate, open below; inner lip smooth; two oblique folds at the posterior end of the anterior canal; columella slopes slightly to the left. Outer lip (fractured); growth lines indicate a weak posterior sinus in the shoulder sulcus, and a straight outer edge anterior thereto; anterior canal short, open, round-ended, inclined slightly to left.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
P33384	13.2	4.9	7.75	c.1.5	5.75
P33419	13.75	5.0	7.5	c.1.5(worn)	5.5

Stratigraphic Range: Aldingan, late Eocene

Material and Occurrence: BC3 FL13 (P33384 1), FL14 (P33419 1).

Comments: The limited amount of BC3 material only differs from the polymorphic *C. protensa* (Tate, 1898) in having a shorter, poorly defined anterior canal and is probably an early form of that species, particularly as its dimensions fall within the range shown by *C. protensa*. Compared with the New Zealand species mentioned above (under *?Cordieria* sp.) it shows a relatively shallow posterior sinus and a broader protoconch but the general morphology is the same.

?Cordieria sp. b.
(Plate 5, figure 13)

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Brown's Creek Clay, FL14 (P33423 4).

Comments: This small fossil has a superficial resemblance to *Splendrillia* Hedley, 1922 and *Tahudrillia* Powell, 1942 Kaiatan (late Eocene) New Zealand, neither of which has columellar lamellae whereas this species has two very faint oblique plaits or a slight thickening about the middle of the columella. There is insufficient material to fully describe it.

Genus **Borsonia** Bellardi, 1839

Type species (monotypy) *Borsonia prima* Bellardi, 1839

Diagnosis: Protoconch: small, c.1.5 smooth whorls. Teleoconch: elongate-fusiform, whorls usually angulated. Aperture narrow, pyriform, with a slightly flexed unnotched anterior canal; typically one, sometimes two, lamellae at about the middle of the columella; outer lip sharp; posterior sinus broadly rounded and moderately deep, covering the whole shoulder slope.

Borsonia tatei Powell, 1944

1944 *Borsonia tatei* Powell, *Rec. Auckland Inst. Mus.* 3(1):42, Pl. 3, fig. 8.

Comment: As a new subspecies, *B. tatei eocenica* is proposed below, the Janjukian fossil should be *Borsonia tatei tatei* Powell, 1944.

Borsonia tatei eocenica subsp. nov.
(Plate 5, figure 18)

Description: Protoconch: paucispiral, 1.0-1.5 whorls, rounded; first whorl smooth; the second has six axials before merging into the teleoconch. Teleoconch: narrowly fusiform with a moderately long, straight, anterior canal. Axial sculpture: low, slightly opisthocline ribs about equal to the interspaces, strongest anterior to the periphery but extending almost to the suture on upper whorls, 7-10, usually 9, per whorl, weakening by the 6th whorl and not extending far below the periphery on the body whorl; numerous very fine growth lines. Spiral sculpture: regular threads, strongest below the periphery where they develop to weak cords on the body whorl, wider than or equal to interspaces; on the shoulder there are usually one, sometimes two subsutural threads, and from nil to five other weak threads; there are one or two peripheral threads, and below the periphery 3-6 cords on the spire whorls and 20-35 cords on the body whorl extending to the tip of the anterior canal. Aperture: lanceolate, pointed above; outer lip probably sharp, with a very shallow arcuate posterior sinus occupying the whole of the shoulder slope, slightly produced anteriorly; inner lip a glaze; one oblique columellar lamella at the top of the columella which tapers gradually to a point above the round-ended anterior canal.

Types: National Museum of Victoria; Holotype P42854, Paratype 1 P42853, Paratype 2 P42856 all coll. T. A. Darragh 24 February 1971.

Type Locality: Brown's Creek Clay, BC1, FL11.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	14.0	4.3	6.6	c.1.5	5.5
Paratype 1	16.0	4.5	8.25	c.1.3	6.0
Paratype 2	13.0	3.6	6.6	1.5	5.5

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Type locality, types and six topotypes (P33379 4, P33374 one, P33357 one).

Comments: *B. tatei eocenica* differs from *B. tatei tatei* in that the spiral sculpture of cords and threads is wider than or equal to the interspaces, and not narrower than or equal to the interspaces as in *B. tatei tatei*. There seem to be no other constant differences between *B.t. eocenica* and *B. t. tatei* although the latter is slightly larger as described (Powell, 1944:42), but this may be because the measurements are of an aged specimen. The protoconch of *B. t. eocenica* with its development of axial ribs in the last half whorl is not strictly typical of *Borsonia* which is said to have a smooth protoconch.

?Borsonia sp. aff. **B. tatei** Powell, 1944
(Plate 5, figure 17)

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Brown's Creek Clay BC3, FL13 (P33397 2); FL14 (P33437 3, P33404 2, P33405 one, P42903 one).

Comments: B. tatei eocenica has yet to be recorded from the BC3 fauna, but this material appears to be a development of it in which the whorls have lost most of their median angulation, the spiral sculpture has become somewhat stronger especially above the periphery, and the weak posterior sinus has virtually disappeared. Although *B. t. tatei* and *B. t. eocenica* fit reasonably into *Borsonia* as diagnosed, the BC3 fossil has no strongly turrid characteristics and

raises doubts as to the validity of the familial placement of the *B. tatei* complex.

Genus **Mitrolumna** Bucquoy, Dautzenberg and Dollfus, 1883

Type species (o.d.) *Mitra olivoidea* Cantraine, 1835

1922 *Mitrithara* Hedley, *Rec. Aust. Mus.* 13(6):233

Type species (o.d.) *Columbella alba* Petterd, 1879.

Comment: The writer agrees with Cernohorsky (1975:232) that there are no significant conchological differences between *Mitrolumna* and *Mitrithara.*

?Mitrolumna sp.
(Plate 6, figure 1)

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Brown's Creek Clay, FL14 (P33435 3).

Comments: Although lacking internal lirations of the outer lip this fossil resembles *Mitrolumna.* It has a small, elongate-ovate, fairly strong, teleoconch; 11-14 low inconspicuous orthocline ribes per whorl produce tubercles where they cross the spiral cords. Its relatively conspicuous domed protoconch resembles *Itia* Marwick, 1931 (type *I. clathrata* Marwick 1931) which Powell (1966) regarded as a subgenus of *Mitrithara*, but lacks *Itia*'s half whorl of brephic axials.

Genus **Cryptocordieria** gen nov.

Type species: *Cryptocordieria variabilis* sp. nov.

Diagnosis: Protoconch: paucispiral, smooth, dome-shaped, 1.6-1.8 whorls followed by up to a whorl of brephic axials. Teleoconch: strong, fusiform, tending to ovate-fusiform; spire about 0.5 height of shell; whorls supramedially angulated with a slightly concave shoulder slope; body whorl narrowing (scarcely excavated below) into a short, open, round-ended anterior canal. Axial sculpture: slightly sigmoidal and opisthocline axial ribs from suture to suture on spire whorls, becoming more spaced and weaker with age. Spiral sculpture: numerous fine cords of variable strength, sometimes obsolete over whole whorl. Aperture narrowly pyriform to slightly rhomboid; columella slightly concave anteriorly and twisted; outer lip sharp, simple, slightly curved forward below periphery; posterior sinus shallow, on shoulder slope.

Comments: The relationships of this genus are not clear. In the writer's view it resembles *Antiguraleus* Powell, 1942 which is placed in the subfamily *Mangeliinae*, but it is also a relatively large, thick-shelled, fossil with a shallow posterior sinus and a twisted, slightly thickened, columella suggestive of a link with *Cordieria*, *Borsonia* and their allies.

Cryptocordieria variabilis sp. nov.
(Plate 6, figures 2, 3)

Description: Protoconch: paucispiral, 1.6-1.8 whorls, slightly assymetric, dome-shaped, flattened above; tip semi-immersed, not deviated; smooth; merging into teleoconch by development of 10 or more rounded, nearly orthocline brephic ribs from suture to suture. Teleoconch: fusiform to ovate-fusiform; spire slightly more than half height of shell; whorls with a shallow concave shoulder after about 2 whorls, widest at the rounded periphery; body whorl tapering gently below into a fairly short, broad, open, round-ended anterior canal; suture margined by a narrow cord on upper two whorls. Axial sculpture: spaced, narrow, slightly sigmoidal and opisthocline ribs traceable from suture to suture on spire whorls, dying out anterior to periphery when present on body whorl, elongately tuberculate on and near the periphery; axials number 14-23 (including brephic axials) on first whorl, and 10 or 11-7 per whorl, tending to reduce with age, on succeeding whorls; they may persist for up to 6 whorls or weaken and gradually disappear after 3.5-4.0 whorls (see comments); numerous threadlike growth lines allow the former posterior sinus position to be traced. Spiral sculpture: numerous fine threads, strongest below periphery over spire whorls and extending to very near end of anterior canal, variable in strength. In some specimens the growth lines and spiral threads create a reticulation. Aperture: elongate, narrowly pyriform, slightly rhomboid; inner lip a glaze on the columella which is slightly twisted anteriorly and excavate

posteriorly with a tendency to a median swelling; outer lip thin, sharp-edged, curved back on shoulder in a narrow posterior sinus with apex just above the periphery (traceable from start of shoulder on teleoconch whorls), and curved very gently forward anteriorly; anterior canal moderately long to short, nearly straight, open, unnotched.

Types: National Museum of Victoria; Holotype P33395, Paratype 1 P42857, Paratype 2 P33394 all coll. T. A. Darragh, 20 November 1970.

Type Locality: Brown's Creek Clay, BC3, FL13.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	23.2	7.4	12.5	1.8	6.2
Paratype 1	13.5	5.0	7.1	c.1.8	4.8
Paratype 2	11.0	4.3	6.0	1.85	4.1
P33363	11.7	4.25	6.1	1.75	4.9

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Brown's Creek Clay; FL11 (P33363 1, P42859 2); Type locality (FL13) (types plus P42858 1, P33386 1); FL14 (P33402 2, P33413 1, P33418 4, P33439 10, EB007 1).

Comments: Both the axial and the spiral sculpture of *Cryptocordieria variabilis* varies in strength. The specimens available from FL11 and FL13 have relatively persistent axials, crisp spiral sculpture, and well-marked growth lines, while those from FL14 have fine low spiral sculpture (though the difference is somewhat exaggerated as specimens are often somewhat rolled), and a greater tendency for the axial sculpture to weaken. However, all the material falls within a range of variation which it is reasonable to expect in one species.

Subfamily: CLAVINAE Casey, 1904

Genus **Splendrillia** Hedley, 1922

Type species (o.d.) *Drillia woodsi* Beddome, 1883.

Diagnosis: Protoconch paucispiral, bluntly rounded, smooth. Teleoconch claviform; spire tall; body whorl rapidly contracted below into a short, rather straight, shallowly notched anterior canal. Sculpture: prominent axial ribs separated from the posterior suture by the shoulder sulcus; shell surface typically smooth and glossy (Hedley's, 1922:250, distinguishing characteristic for *Splendrillia*; Powell, 1966:83, mentions that *Splendrillia* spp can develop spiral striae or lirations). Aperture: ovate lanceolate, open below into a short wide anterior canal which is shallowly notched; outer lip thin edged, slightly thickened behind, with a slight stromboid notch; a heavy entering callus pad at the posterior end of the inner lip; posterior sinus on the shoulder.

?Splendrillia sp.
(Plate 6, figures 4, 5)

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Brown's Creek Clay; FL11 (P42860 1), FL 14 (P33409 1, P33422 2).

Comments: These four specimens clearly relate to *Splendrillia* but have a porcellanous rather than a glossy surface, and lack both a parietal callus pad and, apparently, a 'stromboid' notch on the outer lip.

Splendrillia hughesi sp. nov.
(Plate 6, figure 6)

Description: Protoconch: paucispiral, of 2 whorls; first whorl rounded above with tip partially immersed, may overhang second whorl; suture well defined; either merges into teleoconch or has a well defined junction with a rounded posterior sinus; smooth. Teleoconch: fusiform, glossy; spire about 0.6 height of shell; whorls widest at the rounded periphery which is median on upper whorls and slightly supramedian and sharp on lower whorls; shoulder concave; suture slightly oblique, weakly margined by posterior edge of whorls; body whorl short, rendered ovate in section by a prominent rounded varix-like rib about half a whorl before the aperture (in the holotype—the only complete specimen) extending to the top of the anterior canal, excavated below into a short, nearly straight anterior canal. Axial sculpture: 10-14 rounded, opisthocline, slightly flexuous axial ribs per whorl, usually extending slightly above the periphery on early whorls but cut off sharply at the periphery on the body whorl, and there not extending far below it (usually reaching anterior suture on upper whorls), markedly weaker or obsolescent after

the prominent rib on the body whorl described above; very fine growth lines discordant with the axial ribs. Spiral sculpture: 3-7, usually 6, low cords on the anterior canal; subsutural margining occasionally developed as a weak cord and, rarely, faint linear traces of sculpture on the penultimate and body whorls. Aperture: narrow, lanceolate; inner lip a relatively thick glaze on the columella with, sometimes, a parietal callus; outer lip sharp, curved back and reflected round a deep semicircular posterior sinus occupying the whole of the shoulder, strongly curved forward below the periphery; there is a weak notch in the outer lip opposite the posterior end of the anterior canal; anterior canal short, very weakly notched (notch only noted in holotype which has a complete aperture).

Types: National Museum of Victoria; Holotype P42862, Paratype 1 P42863, Paratype 2 P42864 all coll. T. A. Darragh and T. Hughes 1 December 1972.

Type Locality: Glen Aire Clay, GSV Loc. AW1.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	10.5	3.8	5.7	2.0	6.0
Paratype 1	11.6	3.9	6.6	2.0	7.0
Paratype 2	9.0	3.0	5.0	2.0	5.9

Stratigraphic Range: Upper Aldingan, early Oligocene.

Material and Occurrence: Type locality (types and topotypes; P33340 13, P42933 15, P42934 7).

Comments: This species is named after one of the collectors of the types. It is not quite typical of *Splendrillia* as the parietal callus pad is poorly developed and not always present, and there is a varix-like rib on the body whorl. The only described Australian fossil *Splendrillia* with similarly weak spiral sculpture is the Pliocene *S. trucidata* (Ludbrook, 1941) which is larger and has a heavily developed parietal callus. *S. hughesi* also resembles the Recent *S. lygdina* (Hedley, 1922) which lacks the spiral sculpture on the anterior canal and the varix-like rib on the body whorl. South-east Australian Middle Miocene fossils, to which the names *Austroclavus glaber* Powell, 1944, *A. teres* Powell, 1944, *A. brevicaudalis* Powell, 1944 and *?A. lygdinopsis* Powell, 1944 have been applied, have a paucispiral protoconch and are not typical of *Austroclavus* Powell, 1942; they also sometimes (coll. writer MM035, MM076) exhibit a varix like fold on the body whorl and are probably congeneric with *S. hughesi*. Probably related early Miocene (Batesfordian) material occurs at Kennedy's Creek (FL43). On the other hand *Austroclavus* with a typical polygyrate protoconch occurs in the early Miocene (Longfordian and Batesfordian) of Victoria (undescribed material, coll. writer, LF015, LF016, MK062, MK063, MK064).

Subgenus **Hauturua** Powell, 1942

Type species (o.d.) *Syntomodrillia (Hauturua) vivens* Powell, 1942.

Splendrillia (?Hauturua) sp.
(Plate 6, figure 7)

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Brown's Creek Clay, FL13 (P33381 1); FL14 (P42890 1).

Comments: This small fossil somewhat resembles *Hauturua* Powell, 1942 in its general form and axial sculpture, but has definite spiral sculpture which *Hauturua* is said to lack. There is insufficient material to describe it.

Genus **Mauidrillia** Powell, 1942

Type species (o.d.) *Mangilia praecophinodes* Suter, 1917.

Diagnosis: Protoconch: smooth, globular, of 2 whorls. Teleoconch: claviform; spire turretted, moderately tall; body whorl with a short, very shallowly notched, anterior canal. Axial sculpture: weak to moderately strong axials, mainly on periphery. Spiral sculpture: dense cords or threads overriding axials; subsutural margining cord weak or absent. Posterior sinus broad, rather shallow, occupying most of shoulder area. Parietal callus absent.

Mauidrillia aldingensis Powell, 1944
(Plate 6, figure 8)

1944 *Mauidrillia aldingensis* Powell, *Rec. Auckland Inst. Mus.* 3(1): 36, Pl. 4 fig. 6.

1966 *Mauidrillia aldingensis* Powell, 1944; Powell, *Bull. Auckland Inst. Mus.* 5:87.

Description: Protoconch: 1.3-c.2.0, usually 1.5, whorls, dome-shaped, smooth, tip deviated, slightly flattened; junction with teleoconch not distinct. Teleoconch: claviform; spire about two-thirds height of shell; whorls slightly angled at the periphery with a weakly concave shoulder slope; body whorl very slightly excavate into a short open anterior canal, curved slightly to the left. Axial sculpture: low, rounded, slightly opisthocline axial ribs, somewhat tuberculate on the periphery, 11-15 on first whorl, 8-14, usually about 10, per whorl on succeeding whorls, from just above periphery to anterior suture on spire whorls but weakening and largely confined to the periphery by the fourth to fifth whorls; numerous fine growth lines, slightly thread-like on the shoulder. Spiral sculpture: a narrow sharp subsutural cord followed on the shoulder by spiral threads which increase in number from one up to 5 with age; a cord on the peripheral angulation is followed by 1-3 (usually 2-3) fine cords anteriorly; on the body whorl the subsutural cord is often no stronger than the rest of the spiral sculpture on the shoulder; on, and anterior to, the periphery about 21-27 cords extend to the end of the anterior canal. Aperture: lanceolate, constricted at top of anterior canal; inner lip smooth, columella almost straight; outer lip sharp edged, curved back on shoulder in a round-apexed, V-shaped, posterior sinus with the apex in mid-shoulder; curved gently forward below periphery (no apparent 'stromboid' notch); anterior canal short, termination slightly oblique and weakly notched.

Types: Auckland Institute and Museum; Holotype TM1024, and one Paratype.

Type Locality: Blanche Point Formation, Blanche Point, Aldinga, S. Australia.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	9.5	3.8	—	—	—
P33447	7.8	2.8	4.5	1.5	5.0
P33447	8.5	3.4	5.0	1.5	4.9
P33443	8.9	3.3	5.0	1.5	5.2
P33443	7.6	2.9	4.3	1.5	4.5
EB005	11.5	4.2	6.5	?2.0 (worn)	6.0

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Type Locality (P33447 2 topotypes); Brown's Creek Clay, FL14 (P33443 6, EB005 4).

Comments: The large EB005 specimen whose dimensions are given above develops a broad subsutural margining fold after the fourth and later whorls. *M. aldingensis* is likely to be ancestral to the Oligocene-Miocene species *M. torquayensis* Powell, 1944, *M. pullulascens* (Tenison Woods, 1877), *M. trispiralis* Powell, 1944, *M. consutilis* (Tenison Woods, 1879), *M. partinoda* Powell, 1944 and *M. serrulata* Powell, 1944.

Mauidrillia secta secta (Powell, 1944)
(Plate 6, figures 9, 10)

1944 *Mauidrillia secta* Powell, *Rec. Auckland Inst. Mus.* 3(1):37, Pl. 4, fig. 10.
1966 *Mauidrillia secta* Powell, Powell, *Bull. Auckland Inst. Mus.* 5:87.

Description: Protoconch 1.5 whorls, rounded, tip deviated slightly flattened; smooth with three weak corrugations just before the junction with the teleoconch; suture well-marked; junction with teleoconch well-defined, with a posterior sinus. Teleoconch: fusiform; spire turretted, about 0.54 height of shell; whorls widest at periphery with a strong angulation, median on upper whorls, post-median on lower whorls; shoulder concave; suture slightly oblique; body whorl angulated at periphery, slightly excavated below into a short open anterior canal turned slightly to the left. Axial sculpture: 11-13 sharp opisthocline, abapical ribs, slightly tuberculate at shoulder; from periphery to anterior suture on spire whorls, and from periphery to top of anterior canal on body whorl. Spiral sculpture: a well-defined subsutural cord tending to fade on the body whorl; 2-3 faint incised lines on anterior slope of spire whorls; 5 spiral lines on the body whorl below the periphery, and 4 on the upper part of the anterior canal; 2-5 weak spiral ribs on the lower part of the anterior canal. Aperture (imperfect and matrix-filled) pyriform, narrowed below into anterior canal; inner lip smooth, slightly incised into columella margin; outer lip probably sharp; well-defined rounded posterior sinus on shoulder, apex in mid-shoulder; lip curved forward anteriorly.

Types: Auckland Institute and Museum; Holotype TM1031.

Type Locality: Blanche Point Formation, Blanche Point, Aldinga, S. Australia.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
(Holotype) (Powell, 1944:37)	12.0	4.5	–	–	–
P33448	11.1	4.5	6.1	1.5	4.75
P33444	10.4	4.25	5.5	c.1.5	4.5

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Topotype, P33448 (G. B. Pritchard collection); Brown's Creek Clay, FL14 (P33444 1, EB018 1 spire).

Comments: Mauidrillia secta secta seems not to be a common species. An early form from BC1, which may merit sub-specific separation is recorded below, and a later form from AW1 with more persistent and numerous axials is described as *M. secta otwayensis* subsp. nov. The *Mauidrillia secta* series seems to have developed by a progressive strengthening of both the spiral and axial sculpture, and eastern (Victorian) and western (S. Australian) populations may also have separable differences but more material is necessary to verify this. The holotype approaches the BC1 material in having axial ribs which do not reach the anterior suture, but in P33448, P33444 and EB018 the axials reach the anterior suture on the spire. Both BC3 specimens have more axials per whorl than the holotype and topotype, 14-17 on P33444 and 15 on EB018.

Mauidrillia sp. cf. **secta** Powell, 1944
(Plate 6, figure 12)

Description: Protoconch: 1.5-2.0 smooth rounded whorls, tip deviated, flattened on top; on one specimen the junction with the teleoconch is well-defined and sinuate; another has brephic axials. Teleoconch: narrowly claviform; spire about 0.56 height of shell, turretted; whorls medially sharply angulate, widest at periphery; shoulder sloping, shallowly concave; body whorl slightly excavate anteriorly into a short, oblique-ended, unnotched, almost straight anterior canal. Axial sculpture: short, low, narrow, opisthocline, abapical ribs, extending slightly above the periphery on the first whorl, not reaching the anterior suture and confined to the periphery by the body whorl, 10-16, averaging about 14, per whorl. Spiral sculpture: a weak, slightly beaded subsutural cord which becomes obsolete after 4-5 whorls; one or two faint traces of spiral lines on the shoulder; 1-3 faint incised spiral lines develop anteriorly to the periphery starting on the second-forth whorls; 10-12 low, slightly rounded to flat spiral cords on the anterior part of the body whorl and the anterior canal. Aperture (broken on all specimens): lanceolate; inner lip a glaze on the columella; the outer lip has a U-shaped posterior sinus occupying the whole shoulder slope, and is produced forward anteriorly.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
P33377	13.8	4.5	8.0	1.5	5.8
P33377	10.9	4.0	6.0	c.2.0	5.3
P33377	11.0	3.8	6.3	1.5	5.6

Stratigraphic Range: Aldingan, Late Eocene.

Material and Occurrence: Brown's Creek Clay BC1 FL11 (P33377 3).

Comments: These stratigraphically earlier specimens differ from *M. secta secta* in being narrower in proportion to their length; in the weak and evanescent subsutural cord, in the weak development of the axial ribs, and in a relatively longer and less concave shoulder. It is probably subspecifically distinct from *M. secta secta* but more material is needed to verify this.

Mauidrillia secta otwayensis subsp. nov.
(Plate 6, figure 11)

Description: Protoconch: paucispiral, 1.5-1.75 whorls; tip slightly immersed; first whorl dome-shaped, somewhat flattened on top, second sub-cylindrical to slightly angulated; smooth apart from occasional weak corrugations near the junction with the teleoconch; junction with teleoconch variable, either indistinct, or well-defined with a rounded posterior sinus. Teleoconch: fusiform; spire turretted, about 0.57 height of shell; whorls post-medially angulated with a narrow sulcate shoulder; body whorl excavate anteriorly into a fairly short, straight, unnotched anterior canal inclined

slightly to left; suture slightly oblique, margined anteriorly. Axial sculpture: close opisthocline slightly curved narrow ribs about equal to interspaces, from periphery to anterior suture on spire whorls and traceable to top of anterior canal on body whorl, 15-24 (usually more than 17 and occasionally up to 28) per whorl. Spiral sculpture: a persistent subsutural cord, usually finely beaded by the intersection of axial growth lines; often 1-2 faint spiral lines on the shoulder; 1-4 (usually 2-3) incised spiral lines below the periphery on spire whorls; 5-6 deeply incised spiral lines on body whorl, the interspaces becoming progressively more convex to develop as 8-10 cords on the anterior canal. The degree of depth of sculpture varies, and in some cases, the interspaces between the spiral lines on the body whorl develop as convex cords anteriorly, and the intersection of the spiral and axial sculpture often produces a reticulate tuberculation on the body whorl. Aperture: lanceolate, pointed posteriorly, open below into the anterior canal; inner lip a porcellanous glaze on the columella which tapers to a point at the termination of the anterior canal; outer lip sharp, curved back in an open U-shaped posterior sinus, with a mid-shoulder apex, occupying the whole shoulder, produced in a strong forward curve anteriorly, and curved back to the anterior canal.

Types: National Museum of Victoria, Holotype P42865, Paratype 1 P42866, Paratype 2 P42867, all collected T. A. Darragh, T. Hughes 1 December 1972.

Type Locality: Glen Aire Clay, GSV locality AW1.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	11.1	4.25	6.5	1.6	5.0
Paratype 1	10.6	4.0	6.2	1.5	5.0
Paratype 2	11.4	4.5	6.2	1.5	5.0

Stratigraphic Range: Upper Aldingan, early Oligocene.

Material and Occurrence: Type locality (types plus topotypes: P33330 12, P33341 5, P42935 1, P42936 2).

Comments: M. secta otwayensis differs from the limited amount of *M. secta secta* material available in its generally stronger sculpturing, more numerous axial ribs (15-28 vice 11-17 per whorl) which persist farther anteriorly, slightly narrower shoulder sulcus, and longer anterior canal which carries 8-10 cords compared with 2-5 in *M. secta secta*, in being slightly narrower in proportion to its height (breadth = c.0.37 of height in *M. secta otwayensis*, c.0.39 in *M. secta secta*), and in the spire being slightly longer in proportion to total length (0.58 total length in *M. secta otwayensis*, 0.54 in *M. secta secta*). Whether it is sufficiently different from *M. secta secta* to be regarded as a separate species is questionable; it does not depart from *M. secta secta* in developing any completely new features, and it is possible that the BC3 population of *M. secta* will prove with more material to be intermediate between the population at the type locality and that at GSV locality AW1.

Genus nov?

(Plate 6, figure 13)

Comments: Three specimens, one from FL13 (P33388 sinistral) and two from FL14 (P33427 sinistral, P33430 dextral) represent a genus of 'clavinid' turrids. However no decscribed 'clavinid' genus combines a protoconch followed by a half whorl of brephic axials, a relatively long shoulder slope, and variability in the direction of its coiling.

Subfamily CONORBIINAE Pilgrim in Vredenburg, 1925

Genus **Conorbis** Swainson, 1840

Type Species (monotypy) *Conus dormitor* Solander, 1766.

Diagnosis: Shell coniform. Protoconch smooth, broadly conical, paucispiral. Teleoconch: spire broadly conical; body whorl long and evenly tapered; axial sculpture dense interstitial growth lines; spiral sculpture numerous cords. Aperture long, narrow, parallel sided. Posterior sinus well marked with a straight, prosocline posterior edge and apex just above periphery. Anterior lip produced forward in a sweeping curve below the periphery. Inner lip a smooth glaze on the columella.

Comment: Conorbis spp. are found both in the

Brown's Creek Clay (BC3) and the Glen Aire Clay; they are like, but not identical to, *C. atractoides* Tate, 1890.

Conorbis sp.

Material and Occurrence: Brown's Creek Clay, FL14 (EB006 one complete, one crushed).

Comments: The only complete specimen is probably a juvenile. There is not enough material to describe the BC3 fossils which differ from *C. atractoides* Tate, 1890 in a more simply sculptured spire and spaced linear sculpture on the body whorl.

Conorbis atractoides (Tate, 1890)
(Plate 6, figure 14)

1890 *Conus (Conorbis) atractoides* Tate, *Trans. R. Soc. S. Aust. 13(2):200,* Pl. 13, fig. 7.
1944 *Conorbis atractoides* Tate, 1890, Powell, *Rec. Auckland Inst. Mus.* 3(1):23.
1966 *Conorbis atractoides* Tate, 1890, Powell, *Bull. Auckland Inst. Mus.* 5:95.

Types: South Australian Museum, Adelaide, Holotype T750A, Kent Town Bore, late Eocene.

Conorbis atractoides otwayensis subsp. nov.
(Plate 6, figure 15)

Description: Protoconch: 1.75-2.0 whorls, smooth, tip inrolled and slightly depressed; second whorl rounded; suture distinct; junction with teleoconch straight, indicated by start of spiral sculpture. Teleoconch: biconic; spire conical, straight, or slightly convex or concave sided depending on tightness of coiling of shell; whorls rounded, in some specimens with an indistinct periphery; body whorl with a rounded posterior angulation, a short sloping shoulder slope, and a long posterior portion tapering gradually to a short open anterior canal. Axial sculpture: very numerous fine, incised axial growth lines, most prominent as reticulations in the interspaces between cords on the upper part of the whorls but traceable to the end of the anterior canal. Spiral sculpture: a sometimes bifid subsutural cord is followed by up to four major and two minor spiral cords with sulcate interspaces on the shoulder; on the anterior part of the spire whorls and often obscured by succeeding whorls are up to seven close flat spiral cords with linear interspaces, often indistinct; on the body whorl up to 40 fine flat spiral cords with linear interspaces are crossed by axial growth lines; the interspaces become wider anteriorly so that up to 14 low cords are developed on the anterior canal. Aperture: narrowly lanceolate, widening slightly at the top of the anterior canal; inner lip a glaze on the columella, smooth (with traces of underlying spiral sculpture near the edge) forming a callus on the anterior canal; outer lip sharp edged; a wide, shallowly curved, posterior sinus occupies the entire shoulder slope with its apex slightly anterior to the mid-shoulder; the lip is then curved gently but pronouncedly forward in a long curve anteriorly. Anterior canal short, straight, open, square-ended.

Types: National Museum of Victoria, Holotype P42959, Paratype 1 P42960 both coll. T. A. Darragh 10 March 1977; Paratype 2 P42868 coll. T. A. Darragh and T. Hughes 1 December 1972.

Type Locality: Glen Aire Clay, GSV Locality AW1.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	19.75	8.75	8.2	1.75	5.9
Paratype 1	22.8	10.2	9.0	2.0	6.2
Paratype 2	16.9	8.6	5.8	1.8	5.25

Stratigraphic Range: Upper Aldingan, early Oligocene.

Material and Occurrence: Type locality (Types plus topotypes P33332 12, P42869 1, P42870 1, P42937 32, P42938 9).

Comments: C. atractoides otwayensis differs from *C. atractoides* s.s. in having a protoconch of 1.75-2.0 rather than 2.5 whorls, in being slightly wider in proportion to its length with a relatively more obtuse spire, in developing more numerous spiral cords (up to 11 vice 6 on spire whorls), in the growth lines producing reticulation rather than punctuations in the cord interspaces on the spire whorls, and in the lack of punctuation of the cord interspaces on the body whorl.

Subfamily MANGELIINAE Fischer, 1887

Genus **Guraleus** Hedley, 1918

Type species (o.d.) *Mangelia picta* Adams and Angas, 1864.

Diagnosis: Shell small, elongate fusiform, spire tall, usually turretted; body whorl narrow, tapering to a relatively short, weakly notched anterior canal. Protoconch small, broadly conical with a small, smooth, symmetrical nucleus; second whorl also smooth but much larger, the third whorl with fine axial riblets gradually merging into the adult sculpture. Adult sculpture with dominant axials usually crossed by weak cords and fine threads. Aperture rather narrow, outer lip thin. Posterior sinus a broad shallow excavation occupying most of the shoulder slope.

Guraleus eocenicus sp. nov.
(Plate 7, figure 2)

Description: Protoconch: polygyrate, conoid, 3.0-3.75 rounded whorls with a deep suture; mostly smooth but numerous (20-30) arcuate axial ribs from suture to suture on the last half whorl; tip exposed, slightly depressed below top of protoconch and slightly deviated; protoconch merges gradually into teleoconch as axials become more spaced. Teleoconch: small, buccinoid-fusiform; spire about, or slightly less than, 0.5 height of shell; suture well marked, slightly oblique; first two spire whorls rounded; a peripheral angulation and a shoulder slope, which becomes shallowly concave, develop by the third whorl and the anterior portion of the whorl is then almost straight. Body whorl angulated posteriorly, rounded anteriorly, and gently excavated into a short anterior canal curved slightly to the left. Axial sculpture: 13-17, usually 10-13 narrow axial ribs per whorl, with slightly wider interspaces, curved on the upper part of the whorl and opisthocline anteriorly, from suture to suture on spire whorls, and to just above the anterior canal on the body whorl; by the third whorl the ribs are much weaker on the shoulder, where they parallel the posterior sinus, and are slightly spinose on the whorl periphery; numerous fine axial growth lines indicate the position of the posterior sinus on early whorls and are not quite parallel with the axial ribs. Spiral sculpture: spiral threads overriding the axials, finer on the upper part of the whorl and shoulder than anteriorly, and extending to the end of the anterior canal; 7-13 on the first whorl, increasing to 7-8 spirals on the shoulder and up to 11 anteriorly on spire whorls, and up to 20-30 variable threads on the body whorl, plus 10-12 fine cords on the anterior canal. Aperture: narrowly rhomboidal; inner lip smooth, slightly incised on the parietal wall of the body whorl; the glaze on the columella lip narrows anteriorly to disappear before the end of the short, open, round-ended, unnotched anterior canal; outer lip sharp edged with a well defined curved posterior sinus occupying the whole of the shoulder, apex in mid-shoulder (traceable by growth lines to early whorls), and produced gently forward anteriorly with a suggestion of a weak sinus at the top of the anterior canal.

Types: National Museum of Victoria; Holotype P42871 coll. D. C. Long 11 June 1972, Paratype 1 P42872, Paratype 2 P42873 both coll. T. A. Darragh and H. E. Wilkinson 6 December 1968.

Type Locality: Brown's Creek Clay, BC3, FL14.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	6.2	2.75	3.0	c.3.75	3.0
Paratype 1	4.5	2.1	2.4	c.3.3	2.6
Paratype 2	4.9	2.3	2.6	3.5	2.5
P33411	6.25	2.6	3.5	c.3.2	3.5

Stratigraphic Range: Aldingan, late Eocene—? early Oligocene.

Material and Occurrence: Type locality (types plus EB008 7, P33411 1, P33425 2). Blanche Point Formation; Blanche Point (EA005 2 juveniles); cliff base ½ mile N. of Port Willunga (EW003 2 juveniles). Glen Aire Clay, GSV locality AW1 (?P42940 1 juvenile).

Comments: The material registered under P33425 is intermediate in character between the BC1 specimens and the types. On balance the fossil appears to be *Guraleus* ss. See below for comments on Australian fossil relations.

Guraleus sp. cf **eocenicus** nov.
(Plate 7, figure 1)

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Brown's Creek Clay BC1, FL11 (P33370 3).

Comments: This fossil differs from *G. eocenicus* sp. nov. in the teleoconch whorls being more strongly angulated, in having slightly fewer axial ribs per whorl (10, not 13-17), and in having slightly more protoconch whorls. It is probably not specifically distinct from *G. eocenicus. G. eocenicus* is the first of a series of fossil Australian *Guraleus* spp. with a polygryate protoconch of which the early whorls are smooth and the latter part is axially ribbed, and in which adult sculpture besides axial ribs consists of fine spiral threads and axial growth lines. Later fossils in this series occur from at least the Janjukian (U. Oligocene) to the Balcombian (M. Miocene) and include the named species *G. janjukiensis* Powell, 1944 and *G. harrisi* Powell, 1944; the main evolutionary trend appears to be towards progressively less angulated whorls.

Genus **Antiguraleus** Powell, 1942

Type species (o.d.) *Antiguraleus otagoensis* Powell, 1942.

?**Antiguraleus** sp. a.
(Plate 7, figure 5)

Stratigraphic Range: Aldingan, late Eocene-early Oligocene.

Material and Occurrence: Brown's Creek Clay, FL14 (EB009 one juvenile, one body whorl 4.0 mm long); Glen Aire Clay, GSV loc. AW1 (P42889 1).

Comments: This small fossil with a paucispiral protoconch, 19-20 sinuous ribs per rounded teleoconch whorl, a spiral sculpture of 10-15 faint spiral lines on the anterior of the body whorl and 7-8 low cords on the canal is probably an *Antiguraleus* but there is insufficient material to describe it or determine if the Brown's Creek Clay and Glen Aire Clay specimens are the same species.

Antiguraleus sp. b.
(Plate 7, figure 3)

Stratigraphic Range: Upper Aldingan, early Oligocene.

Material and Occurrence: Glen Aire Clay, GSV locality AW1 (P33338 2, P42942 1, P42943 1, P42944 1).

Comments: A small, ovately fusiform, shell with a smooth paucispiral protoconch of 1.5-1.75 whorls and teleoconch sculpture of 14-16 flexuous ribs and numerous fine overriding spiral threads; it has a weak but clear posterior sinus on the shoulder. It appears to be a typical *Antiguraleus* and differs from *?A.* sp. a. in its fewer axial ribs and more prominent spiral sculpture.

?**Antiguraleus** sp. c.
(Plate 7, figure 4)

Stratigraphic Range: Aldingan, late Eocene-early Oligocene.

Material and Occurrence: Brown's Creek Clay, BC3, FL14 (P42892 4, ?EB011 1); Glen Aire Clay, GSV locality AW1 (P42941 4).

Comments: A small, relatively thick-shelled *Antiguraleus*-like shell, with a very shallow posterior sinus. The 13-15 axial ribs dominate the sculpture of the slightly polished teleoconch on which spiral sculpture is reduced to faint lines on the body whorl and low cords on the anterior canal. AW1 material has even weaker spiral sculpture than that from FL14. It differs from species a. and b. above in the weaker spiral sculpture, shallower posterior sinus, polished surface, and more turretted spire.

Genus **Macteola** Hedley, 1918

Type species (o.d.) *Purpura (Cronia) anomala* Angas, 1877.

Diagnosis: Small; broadly biconical; protoconch, 1.5-2.0 smooth whorls with a blunt tip. Axial sculpture; broad ribs, absent from the shoulder slope and fading over the base. Spiral sculpture: fine threads over whole surface. Aperture subovate; anterior canal short, unnotched; outer lip thin with a very slight sinus occupying the shoulder slope.

Macteola eocenica sp. nov.
(Plate 7, fig. 6)

Description: Protoconch: smooth, polished, subcylindrical, usually 1.5 but up to 1.75 whorls, first rather globose, tip slightly deviated and immersed; usually a slightly sinuate scar at the junction with the teleoconch. Teleoconch: small, fusiform, surface slightly polished, spire 0.5 height of shell; whorls turretted, with a well

defined slightly sulcate, almost level shoulder slope, and supra-medial peripheral angulation, straight sided and narrowing slightly from periphery to suture; body whorl capacious, excavate below into a short anterior canal. Axial sculpture: 10-13 (usually 10-11) very slightly opisthocline, spaced, straight, narrow, axial ribs per whorl, starting about 0.2 whorl after the protoconch scar, in alignment from whorl to whorl, from just below the posterior suture to the anterior suture on spire whorls, dying out at the top of the anterior canal on the body whorl, high and slightly coronated at the peripheral angulation; very faint incised axial growth lines. Spiral sculpture: incised spiral lines over the whole of the spire whorls, the interspaces developed as very flat cords on the body whorl and low cords on the anterior canal, variable in strength, 0-5 lines posterior to the peripheral angulation; up to seven lines anterior to it on spire whorls, 12-18, usually about 15, on the body whorl plus 7-10 low cords on the anterior canal. Aperture: narrow, elongate, bluntly angulated posteriorly, open below; outer lip sharp, nearly straight, very slightly bent back to produce a broad shallow posterior sinus with its apex on the peripheral angulation and very slightly produced forward anteriorly; inner lip a flat matt glaze on the columella, slightly concave in the parietal region, curved gently to the left along the columella; anterior canal, short, open, inclined slightly to the left, unnotched.

Types: National Museum of Victoria; Holotype P42874, Paratype 1 P42875, Paratype 2 P42876 all coll. T. A. Darragh and H. E. Wilkinson, 6 December 1968.

Type Locality: Brown's Creek Clay, BC3, FL14.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	4.5	2.25	2.25	1.5	3.5
Paratype 1	4.5	2.0	2.25	1.5	3.5
Paratype 2	4.45	2.0	c.2.3	c.1.5 (worn)	c.3.6
P33371	4.8	1.9	c.2.5	2.0	3.5

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Brown's Creek Clay, BC1, FL11 (P33371 1); type locality (types plus P33432 12).

Comments: M. eocenica differs from typical *Macteola* in that the axial ribs almost reach the posterior suture, and the extremely shallow sinus has a low apex at the shoulder angulation. However, its other features are typical of the genus. Another possible generic placement is *Mangaoparia* Vella, 1954, only species *M. powelli* Vella, 1954, late Miocene, New Zealand, in which however the aperture is not fully known and in which the axial ribs are absent above the periphery, the protoconch is little more than one whorl, and there is a subsutural fold. Powell (1966, 108) considered it likely that *Mangaoparia* was related to *Macteola*. No other fossil *Macteola* species have yet been recorded.

Genus **Etrema** Hedley, 1918

Type species (o.d.) *Mangilia (Glyphostoma) aliciae* Melvill and Standen, 1895.

Comments: Etrema has been diagnosed as having axial ribs which do not extend to either base or suture (e.g. Powell, 1966:112). However, Hedley (1922, Pl. 47, fig. 70) shows a specimen of the type species in which the axial ribs extend from near the posterior suture to the anterior suture on the spire and to the top of the anterior canal on the body whorl. The axials also extend from suture to suture and to the top of the anterior canal in for example *E. capillata* Hedley, 1922, *E. catapasta* Hedley, 1922, *E. culmea* Hedley, 1922, *E. curtisiana* Hedley, 1922 and *E. elegans* Hedley, 1922.

Etrema sp.
(Plate 7, figure 7)

Stratigraphic Range: Upper Aldingan, early Oligocene.

Material and Occurrence: Glen Aire Clay, GSV loc. AW1 (P33337 2, P42939 2).

Comments: This fossil is a typical *Etrema*. It differs from *E. janjukiensis* Powell, 1944 (late Oligocene, Victoria) in developing more spiral cords per whorl, in having secondary spiral threads, and in having more markedly opisthocline axial ribs extending to the posterior suture. More material is needed to fully describe this species, which is the earliest record of *Etrema* to date.

Subfamily DAPHNELLINAE Casey, 1904

Genus **Asperdaphne** Hedley, 1922

Nom. nov. for *Scabrella* Hedley, 1918, type species (o.d.) *Daphnella versivestita* Hedley, 1912 (non *Scabrella* Sacco, 1890).

Asperdaphne sp. **a**.
(Plate 7, figure 8)

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Brown's Creek Clay BC1, FL11 (P42899 1).

Comments: The spiral sculpture of the protoconch with 4-5 sharp ridges per whorl is coarser than in any Australian Tertiary *Asperdaphne* spp, but the fossil otherwise fits best into *Asperdaphne* (see also general comment on *Asperdaphne* below).

Asperdaphne sp. **b**.
(Plate 7, figure 9)

Stratigraphic Range: Aldingan-Upper Aldingan, late Eocene-early Oligocene.

Material and Occurrence: Brown's Creek Clay, BC1, FL11 (P33368 1); Blanche Point Fmn, ½ mile N. of Port Wilunga (EW004 1); Glen Aire Clay GSV loc. AW1 (P42900 1 incomplete, P42901 1, P42945 3 incomplete).

Comments: More material is needed to evaluate this species complex. Its characteristics are a protoconch with numerous spirals visible under magnification, rounded axial ribs, and more or less closely spaced spiral cords.

Asperdaphne sp. **c**.

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Brown's Creek Clay BC3, FL14, (P33426 1).

Comments: Differs from *Asperdaphne* sp. *a.* in its much smoother protoconch, smaller size, and more angulated whorls, and from *Asperdaphne* sp. *b.* in the smoother protoconch, sharper axial ribs, and weaker sculpture of the posterior sulcus.

General Comments: These fossils carry the history of *Asperdaphne* back to the late Eocene; they are all very similar in general morphology—especially in possessing a distinctive sulcus band marking former positions of the posterior sinus. The Balcombian *A. balcombensis* Powell, 1944 and *A. contigua* Rowell 1944 and undescribed Longfordian to Balcombian material also show this band, though it is generally narrower, and so does the poorly known Recent *A. compacta* Hedley, 1922.

Genus **Rugobela** Finlay, 1924

Type species (o.d.) *Ptychatractus tenuiliratus* Suter, 1917.

Diagnosis: Rather small, up to c. 15.0 mm. Protoconch conical, of 4-5 smooth whorls. Teleoconch elongately ovate-fusiform resembling *Daphnella*; with rounded axial ribs which often die out on later whorls and subsidiary spirals; posterior sinus adjacent to suture, shallow, almost vertical; outer lip produced forwards in a broad arc anteriorly. There are usually several weak oblique plications on the inner lip near the base of the columella.

Rugobela humerosa (Marwick, 1926)
(Plate 7, figures 10, 11)

1926: *Clavatula humerosa* Marwick. *Trans. N.Z. Inst.* 56: 315 Pl.72 f.19.

1942: *Rugobela humerosa* (Marwick, 1926). Powell, *Bull. Auckland Inst. Mus.* 2: 160.

1966: *Rugobela humerosa* (Marwick, 1926). Fleming, *Bull. N.Z. Dep. Sci. Ind. Res.* 173: 76.

1966: *Rugobela humerosa* (Marwick, 1926). Powell, *Bull. Auckland Inst. Mus.* 5: 138.

Description: Protoconch: conoidal, smooth, about 3-4 whorls, tip inrolled and deviated; suture simple; junction with teleoconch indistinct. Teleoconch: ovate-fusiform; spire subconoidal averaging 0.5 (0.46-0.54) height of shell; whorls with a weak angulation at about 0.3 whorl height below periphery producing a narrow shoulder, and very slightly convex anteriorly; body whorl large, tapering with a very slight, excavation into a short anterior canal. Axial sculpture: 10-15, usually 12-14, low rounded opisthocline axial ribs from below the subsutural angulation of the whorl to the anterior suture on the first two whorls; they become obsolete after 2-2½ whorls, or even earlier; numerous very fine axial growth lines. Spiral sculpture: a weak subsutural margining cord on the first two or so whorls; 3-4 faint spiral lines distributed above and below the shoulder on the first three or so whorls; 10-16

flat weak spiral cords with linear interspaces on the lower half of the body whorl, and 10-15 low oblique cords on the anterior canal. Aperture: lanceolate; outer lip sharp with a narrow U-shaped sinus immediately anterior to the suture, produced broadly forward anteriorly; inner lip smooth; anterior canal short, open, unnotched.

Types: New Zealand Geological Survey; Holotype TM5791.

Type locality: NZGS macrofossil locality GS 1100, tuffaceous conglomerate, slumped block on hillside above former Lorne railway station near Weston, North Otago-Waireka Volcanics formation, Kaiatan, late Eocene (P.A. Maxwell pers. comm. 5.1.1981).

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	11.5	5.0		c.4.0	5.0
Topotype 9481	12.4	c.4.5	6.1	c.3.0.	c.5.0.
Topotype 9481	12.9	5.1	6.7	c.3.0.	c.5.1.
P42877	15.5	5.8	8.2	3.0	5.5
P42878	12.5	5.4	6.3	2.0 preserved	5.0

Stratigraphic Range: late Eocene (Kaiatan and Aldingan)-Early Oligocene (Runangan and possibly Whaingaroan) P. A. Maxwell pers. comm. 5.1.1981.

Material and Occurrence: New Zealand: type locality (NZGS Reg. Nr. 9481, 9 topotypes). Victoria: BC1, FL11 (P33355 5, P33362 1, P33376 1, P42877 1, P42878 1).

Comments: R. humerosa has weaker spiral sculpture than other species of *Rugobela;* it is also characterised by a lack of oblique plications at the anterior end of the columellar lip. The other Eocene species tentatively assigned to *Rugobela, ?R. oborni* Marwick, 1960 has very strong columellar plications. *R. humerosa* is the only late Eocne New Zealand turrid species identified in this paper as also occurring in the late Eocene of Victoria. From the limited amount of material available no significant differences are observable between New Zealand and Victorian specimens.

In Australia *R. exsculpta* Powell, 1944 has more numerous and persistent axial ribs. *R. columbelloides* (Tenison Woods, 1877) has a stronger spiral sculpture and columellar plications; *R. columbelloides* appears to be a senior synonym of *R. conospira* (Tate, 1898, nom. nov. for *Thala marginata* Tenison Woods, 1877) as May (1919: 22) considered *Thala marginata* a synonym of *R. columbelloides* (Tenison Woods, 1877); (*Daphnella columbelloides* Tenison Woods, 1877: 103 has page priority over *Thala marginata* Tenison Woods, 1877: 108). The writer has not been able to examine types or topotypes of *R. columbelloides* but Longfordian-Bairnsdalian material (coll. writer) does not appear to include more than one species of *Rugobela.* These Victorian fossils not only differ from *R. humerosa* as does *R. columbelloides,* as described, but also differ in having a less rounded posterior sinus more like the genotype, in tending to develop axial ribs on the last half whorl of the protoconch, and in having an exsert tip to the protoconch present in well preserved, usually juvenile, material.

Doubtfully Turrid species

Genus **Syngenochilus** Powell, 1944

Type species (o.d.) *Syngenochilus radiapex* Powell, 1944

Diagnosis: Shell ovate-fusiform with a bluntly rounded apex. Protoconch small, flattened, one half whorl with a flattened tip followed by a whorl of usually slightly opisthocline axial ribs merging into the teleoconch. Teleoconch whorls have a subsutural sulcus, anterior to which whorls are straight sided; adult sculpture rounded axial ribs and narrow spiral cords or incised lines. Aperture narrow; posterior sinus scarcely produced; weak oblique plications present on the columella.

Comments: Resembles *Teleochilus* Harris, 1897 (Type species *Daphnella gracillima* Tenison Woods, 1876) which has a spirally striate not a radially costate protoconch, weak oblique columellar plications like *Syngenochilus*, and is a late Oligocene to Recent south east Australian genus. The assignment of *Teleochilus*, and by analogy, *Syngenochilus,* to the Turridae is commented on below under *Parasyngenochilus* gen. nov.

Syngenochilus johannaensis sp. nov.
(Plate 7, figure 12)

Description: Protoconch: dome-shaped, about 1.5 whorls; the first half whorl is flat and smooth; the next full whorl develops 12-16 slightly curved axial ribs as it merges gradually into the teleoconch. Teleoconch: ovate fusiform; spire 0.42-0.43 height of shell; whorls post-medially angulate with a narrow sloping, slightly concave, shoulder, straight-sided anteriorly; body whorl large, tapered with a very slight excavation into a short anterior canal. Suture with a weak postero-marginal fold. Axial sculpture: 8-16, usually 10-12, spaced low narrow axial ribs per whorl, slightly prosocline on the shoulder, orthocline anteriorly; from suture to suture on the spire whorls, weaker and reaching to the top of the anterior canal on the body whorl; the ribs are weak on the shoulder slope and strongest on the anterior of the whorl, appearing slightly tuberculate at the whorl periphery; numerous fine axial growth lines. Spiral sculpture: numerous even incised spiral lines, 4, increasing to 10, close together on the posterior slope and 5-7 spaced anteriorly on spire whorls; 23-29 on the body whorl and 10-12 weak oblique cords on the anterior canal. Aperture: elongate-lanceolate; outer lip sharp edged, straight; posterior sinus a minor sutural identation; inner lip a smooth glaze on the columella and parietal regions, with occasional (in two of eight available specimens) weak traces of a few oblique columellar plaits; anterior canal short, straight, open, unnotched with a nearly square termination.

Types: National Museum of Victoria; Holotype P33360 coll. T. A. Darragh 18 October 1971; Paratype 1 P33380, Paratype 2 P42879 both coll. T. A. Darragh 24 February 1971.

Type Locality: Brown's Creek Clay, BC1, FL11.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	14.25	5.9	6.5	1.5	4.25
Paratype 1	12.9	5.0	5.7	1.5	4.0
Paratype 2	15.75	5.9	6.75	1.5	4.5
P42880	12.3	4.2	5.3	1.5	4.0

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Type locality; (Types plus P33378 3, P42880 1, P42881 1).

Comments: S. johannaensis differs from *S. radiapex* Powell, 1944 in having widely spaced, persistent, (not close and evanescent), axial ribbing; in having pronouncedly angulated, not rounded, whorls, and in the, at most, weak development of columellar plications. Nevertheless the apex and general morphology of the shell are typical of *Syngenochilus*.

Syngenochilus radiapex Powell, 1944
(Plate 7, figures 13-15)

1944 *Syngenochilus radiapex* Powell, *Rec. Auckland Inst. Mus.* 3(1): 66, Fig 9, Pl 6 fig 4.
1966 *Syngenochilus radiapex* Powell; Powell, *Bull. Auckland Inst. Mus.* 5: 138.

Description: Protoconch: first whorl flat, smooth; second radially costate, merging into teleoconch. Teleoconch: ovate-fusiform; spire about 0.46 height of shell; whorls with a narrow subsutural margin followed by a narrow sulcus, otherwise straight-sided. Body whorl rounded, straightening slightly into a short anterior canal. Axial sculpture: 14-21 strong rounded slightly opisthocline axial ribs per whorl, from suture to suture on spire whorls, becoming obsolete on the body whorl of larger specimens, otherwise fading before reaching the anterior canal; numerous growth lines. Spiral sculpture: crisp narrow spiral cords with linear interspaces cover all whorls and extend to the tip of the anterior canal, 10-14 on spire whorls, 28-35 on body whorl, overriding axials. Aperture: narrow, elongate-ovate, angulate above with a minute sutural sinus; outer lip sharp edged, almost straight, a weak internal rib about 1.0 mm from the edge; inner lip slightly incised into the columellar and parietal regions, smooth except for 3, increasing with age up to 8, oblique plications on the lower part of the columella; anterior canal very short, open, unnotched, with an almost square end.

Types: Auckland Institute and Museum; Holotype TM-1123, and 4 Paratypes.

Type Locality: Torquay Upper Beds, Victoria. (Puebla Formation ?).

Dimensions: .

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	7.25	3.25	–	2.0	3.0
P33334	6.0	3.0	2.0	1.5	2.5
P33334	14.5	5.5	6.7	c.1.5	4.5
P33334	13.2	5.0	6.2	c.1.5	4.5

Stratigraphic Range: Upper Aldingan-Longfordian? (early Oligocene-early Miocene).

Material and Occurrence: Glen Aire Clay, GSV loc. AW1 (P33334 18, P42946 17, P42947 6); Jan Juc formation, Bed B100, clay immediately below Pt. Addis Limestone, W. side Bell's Headland, Victora (OB019 1, coll. K. N. Bell 20 January 1975); above ledge, Bird Rock Cliffs, Torquay, F. A. Cudmore Collection, 2.

Comments: The holotype of *S. radiapex* is probably not fully grown; however the Glen Aire Clay material appears to be the same species, and indicates that the axial sculpture tends to disappear with age, a feature also shown by the fossil from Bell's Headland. It seems, from comparison with Powell (1944, P1 6, fig 4) and the Bell's Headland specimen, that the Glen Aire material has a slightly wider shoulder sulcus, and is less ovate in form, but more Janjukian-Longfordian material is needed to evaluate this.

Genus **Parasyngenochilus** gen. nov.
Type species *P. eocenicus* sp. nov.

Diagnosis: Protoconch: paucispiral, about 1.5 whorls, dome-shaped, top flattened, tip depressed, first whorl smooth, remainder with strangthening orthocline axial ribs merging into the teleoconch. Teleoconch: ovate-fusiform; spire about half height of shell; whorls bluntly angulate, with a subsutural margining fold and concave shoulder slope, sulcate on earlier whorls. Body whorl slightly contracted below into a short open, unnotched, anterior canal. Sculpture of orthocline narrow ribs, often slightly spinulose at the shoulder, with fine spiral lines or flattened cords. Aperture ovate lanceolate; outer lip straight, sharp; inner lip smooth; columella slightly twisted and thickened above termination; posterior sinus at most a slight subsutural notch.

Comments: The general morphology of *Parasyngenochilus* is similar to *Syngenochilus* Powell, 1944; however the smooth portion of the protoconch is dome-shaped and not flat, and the columella does not have oblique plications near its end, although some specimens of the type species have traces of weak lamellae near the mid-columella. *Parasyngenochilus* also appears similar to *Awateria* Suter, 1917 (type species *A. streptophora* Suter, 1917; Miocene-Pleistocene, New Zealand) in which the protoconch is, however, "smooth, of 1½ carinated whorls, the tilted pullus minute, its little apex erect, then immersed into the spire, rising again, leaving a semicircular depression" (Suter, 1917:57), and has some resemblance to late Oligocene-Miocene Australian fossils placed in *Scrinium* Hedley, 1922 by Powell (1944) (*S. duplicatum* Powell, 1944 and *S. nanum* Powell, 1944). Both *Syngenochilus* and the conchologically similar *Teleochilus* Harris, 1897 (late Oligocene-Recent, Australia) have been allied to *Daphnella* (e.g. by Powell, 1966: 138) on account of their having a sculptured protoconch and oblique folds on the columella, although Laseron (1954: 22) regarded *Teleochilus* as a Borsoniinid. However, *S. johannaensis* sp. nov. has at best sporadic and weak columella plaits which indicates that they are probably not original features of the *Syngenochilus* stock, but a later development and, hence, not necessarily of value in establishing the relationship of *Syngenochilus* at a subfamilial level. The resemblance between *Teleochilus, Syngenochilus, Parasyngenochilus, Awateria,* and *Scrinium,* particularly the fossils tentatively ascribed to *Scrinium* such as *S. duplicatum* Powell, 1944, suggests the presence of a discrete group of Prosobranchs, having small buccinoid shells with paucispiral protoconchs and little or no posterior sinus, in Australasian waters since at least the late Eocene. To discover how these fossils relate to the Turridae requires further work; in particular an examination of the soft parts of *Teleochilus royanus* Iredale, 1924 and *Scrinium brazieri* (Smith, 1891) would be of value. One New Zealand species assigned to *Scrinium, S. neozelanica* (Suter, 1908) has been verified as a Turrid (Powell, 1966: 66). Certainly a close relationship between *Syngenochilus* and *Teleochilus* on the one hand and

Daphnella on the other is, on balance, improbable.

Besides the Australian fossils reported below *Parasyngenochilus* is also known by limited material from the late Eocene (Kaiatan)—one specimen—and late Oligocene (Waitakian)—two specimens—of South Canterbury, New Zealand (P. A. Maxwell pers. comm. 1 December 1980).

Parasyngenochilus eocenicus sp. nov.
(Plate 7, figure 16)

Description: Protoconch: paucispiral, about 1.5 whorls; dome-shaped, top flattened, tip depressed; first whorl smooth, remainder with strengthening orthocline axials merging into the teleoconch. Teleoconch: ovate-fusiform, fairly strong; spire 0.50-0.54 height of shell; whorls with a subsutural fold, a narrow concave (sulcate) shoulder slope and an angulation at about 0.25 of whorl height below the suture; they narrow slightly from periphery to anterior suture. Body whorl rounded, narrowing gently anteriorly to a short, open canal. Axial sculpture: 10-14, occasionally up to 19, narrow orthocline ribs per whorl which nodulate the subsutural fold and the whorl periphery, extend from suture to suture on spire whorls and die out about the middle of the body whorl. Spiral sculpture variable and weak; up to six faint incised spiral lines below the periphery on spire whorls, and occasionally developed on the shoulder slope on the penultimate and body whorls; up to 20, usually fewer, faint spiral lines anterior to the periphery on the body whorl, and usually 6-8 (in one case two in another c.13) low fine oblique cords on the anterior canal. Aperture: elongate-ovate; outer lip sharp, almost straight, curved slightly back on the anterior canal; inner lip, smooth, a dull glaze on the columella, slightly curved; anterior canal short, widely open, squarely truncated. Posterior sinus not observed.

Types: National Museum of Victoria; Holotype P42882, Paratype 1 P42883, Paratype 2 P42884, all coll. T. A. Darragh and H. E. Wilkinson 6 December 1968.

Type Locality: Brown's Creek Clay, BC3, FL14.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	9.4	4.5	4.75	1.5	3.5
Paratype 1	11.1	4.8	6.0	c.1.25 (worn)	4.5
Paratype 2	8.8	4.1	4.5	c.1.5	4.5

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Type Locality (types plus P33406 2, P33438 6).

Comments: (see also under genus). In P33438 two specimens have two weak columellar lamellae just below the mid-columella, one has three; all of these have broken outer lips.

Parasyngenochilus angustior sp. nov.
(Plate 7 figure 17)

Description: Protoconch: paucispiral, 1½-2 whorls dome-shaped, tip slightly immersed (in one case flattened), first whorl smooth, second with orthocline to slightly opisthocline rounded strengthenng axial ribs, merging gradually into the teleoconch. Teleoconch: elongately ovate-fusiform; spire about 0.55 height of shell; whorls with a narrowly sulcate shoulder slope and a subsutural margining fold, almost straight-sided anteriorly; suture well marked, very slightly oblique; body whorl slightly narrowed anteriorly into a short anterior canal. Axial sculpture: 14-22 (usually 16-19) orthocline ribs per whorl, narrower than interspaces, from suture to suture on spire whorls, dying out above the anterior canal on the body whorl, slightly nodulose on the subsutural fold and on the cord margining the shoulder; numerous very fine axial growth lines. Spiral sculpture: numerous fine threads and cords from suture to suture on spire whorls and extending as fine cords on to the anterior canal; the threads may become doubled and spaced, or closely crowded with linear interspaces; up to 44 on the body whorl. Aperture: narrow, lanceolate; outer lip sharp edged, curved very slightly forward below the periphery and then slightly back to the anterior canal. Inner lip smooth, porcellanous, slightly curved and slightly incised into the body whorl; two specimens show a weak median fold and thickening on the columella, and one specimen has traces of two minute folds in the same posi-

tion; anterior canal short, open, scarcely distinguished from the body whorl, curved slightly to the left, end almost straight or with a weakly concave edge.

Types: National Museum of Victoria: Holotype P42961, Paratype 1 P42962, Paratype 2 P42963 all F. A. Cudmore collection.

Type Locality: Glen Aire Clay, GSV locality AW1.

Dimensions:

	L.	B.	S.	Protoconch Whorls	Teleoconch Whorls
Holotype	10.0	3.5	5.75	1.45	4.4
Paratype 1	10.5	3.8	6.0	1.75	4.0
Paratype 2	9.1	3.75	5.0	1.6	3.8

Stratigraphic Range: Upper Aldingan, early Oligocene.

Material and Occurrence: Type locality (Types plus P42885 3, P42886 1, P42887 1, P42888 1, P42948 14, P42949 1, P42955 2).

Comments: Differs from *P. eocenicus* in its elongate form, more numerous axial ribs, and better developed spiral sculpture. The indication of columella thickening is more like the fold on *Borsonia* and its allies than the plications of the distal end seen in *Syngenochilus* and *Teleochilus*. One specimen of a *Parasyngenochilus* from the late Eocene (Kaiatan) of GS9508, McCulloch's Bridge, Waihao R. South Canterbury, New Zealand (P. A. Maxwell pers. comm. 1 December 1980) is very similar to *P. angustior* but lacks the nodulation of the subsutural fold and has more widely spaced, rounded, axial ribs. More material is needed to establish its relationships.

?Parasyngenochilus sp. **a.**

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Brown's Creek Clay, B1, FL11 (P33369 2, P33365 2).

Comments: Differs from *Parasyngenochilus* in the conspicuously twisted short anterior canal, in the sharply angulate whorls, the sloping rather than sulcate shoulder slope and in having a subsutural cord rather than a fold. There is otherwise a general resemblance to *Parasyngenochilus* and this fossil may be allied to it.

?Parasyngenochilus sp. **b.**
(Plate 7, figure 18)

Stratigraphic Range: Aldingan, late Eocene.

Material and Occurrence: Brown's Creek Clay, BC1, FL11 (P42905 2); BC3, FL14 (P42906 1, ?EB012 1).

Comments: Like *Parasyngenochilus* sp. a. this fossil is more angulated than *P. eocenicus* or *P. angustior,* with a faintly concave not sulcate shoulder slope; the protoconch and aperture are, however, in agreement with *Parasyngenochilus.*

Mitra citharelloides Tate, 1889
(Plate 7 figure 19)

Type Locality: Lower beds, Aldinga.

Comment: Cernohorsky (1972a) placed this species in the mitromorph Turridae, close to *Vexithara* Finlay, 1926 on the grounds of its possessing two columellar plaits, a siphonal spout and an unnotched and slightly reverted siphonal canal. The writer has seen no material referable to his species. A photograph of the holotype (T631B) shows it to have more rounded whorls than Tate's figure (1889, Pl 5 fig. 11) suggests and than *Vexithara nodosolirata* (Suter, 1917 Powell, 1966, Pl 10 fig 8); the aperture is matrix filled, and there is no clear evidence from the photograph of a posterior sinus.

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Explanation of Plates

PLATE 4

Fig. 1— ? *Comitas* sp., P33342, FL 11, × 2.3.
Fig. 2— *Comitas aldingensis* Powell 1944, paratype, Blanche Pt., × 9.6.
Fig. 3— *Comitas aldingensis* Powell 1944, TM 953, holotype, Blanche Pt., × 11.
Figs. 4, 5— *Comitas wynyardensis cudmorei* supsp. nov., P42956, holotype, AW 1, × 2.5 and × 9.
Fig. 6— Genus ? nov (allied to *Comitas*), P33429, BC 3, × 10.
Fig. 7— *Tholitoma* sp., P33417, BC 3, × 4.6.
Fig. 8— *Makiyamaia victoriae* sp. nov., P42834, holotype, BC 3, × 8.
Fig. 9— *Apiotoma* ? *wilkinsoni* sp. nov., P42832, holotype, BC 3. × 2.
Figs. 10, 11— *Apiotoma* ? *wilkinsoni* sp. nov., P42833, paratype, BC 3, × 3.5 and × 9.
Fig. 12— *Apiotoma bassi* Pritchard 1904, MUGD 1825, holotype, AW 1, × 2.
Fig. 13— ?*Apiotoma* sp. a. P33353, BC 1, × 2.5.
Figs. 14, 15— *Apiotoma* sp. b. P33356, BC 1, × 4 and × 7.3.
Fig. 16— ? *Insolentia* sp. P33416, BC 3, × 6.7.
Fig. 17— ? *Insolentia* sp. P33400, BC 3, × 2.8.

PLATE 5

Figs. 1, 2— *Johannaia darraghi* gen. *et* sp. nov., P42841, holotype, BC 1, × 5 and × 15.
Figs. 3, 4— *Marshallaria otwayensis* sp. nov., P42844, holotype, AW 1, × 3.3 and 7.4.
Fig. 5— *Paramarshallena propebelloides* gen. *et* sp. nov. P42847, holotype, BC 1, × 5.5.
Fig. 6— *Cochlespira semiplana* (Powell 1944), TM 956, holotype, Blanche Point, × 8.
Fig. 7— *Turrinosyrinx denticulata* sp. nov., P33354, holotype BC 1, × 6.
Fig. 8— *Veruturris* sp., P33433, BC 3, × 4.
Fig. 9— *Gemmula (Clavogemmula) prima* subgen. *et* sp. nov., P33350, holotype, BC 1, × 5.
Fig. 10— *Gemmula (Clavogemmula) prima* subgen. *et* sp. nov., P42851, paratype, BC 1, × 8.5.
Fig. 11— ? *Cordieria* sp. a., P33348, BC 1, × 7.5.
Fig. 12— *Cordieria* sp. cf. *protensa* (Tate 1898), P33384, BC 3, × 6.
Fig. 13— ? *Cordieria* sp. b., P33423, BC 3, × 12.
Fig. 14— *Cordieria protensa* (Tate 1898), T340D, holotype, AW 1, × 2.
Fig. 15— *Cordieria protensa* (Tate 1898), T320D, AW 1, × 4. (holotype of *Borsonia otwayensis* Tate 1898, pl. 19, fig. 4).
Fig. 16— *Cordieria protensa* (Tate 1898), T327C, AW 1, × 6.5. (holotype of *Borsonia polycesta* Tate 1898, pl. 19, fig. 2).
Fig. 17— ? *Borsonia* sp. cf. *tatei* Powell 1944, P33405, BC 3, × 6.
Fig. 18— *Borsonia tatei eocenica* subsp. nov., P42854, holotype, BC 1, × 4.5.

PLATE 6

Fig. 1— ? *Mitrolumna* sp., P33435, BC 3, × 11.
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Fig. 4— ? *Splendrillia* sp., P33422, BC 1, × 8.
Fig. 5— ? *Splendrillia* sp., P33409, BC 1, × 5.

Fig. 6— *Splendrillia hughesi* sp. nov., P42862, holotype, AW 1, × 7.
Fig. 7— ? *Hauturua* sp., P33381, BC 3, × 12.
Fig. 8— *Mauidrillia aldingensis* Powell 1944, TM 1024, holotype, Blanche Point, × 8.
Fig. 9— *Mauidrillia secta secta* Powell 1944, TM 1031, holotype, Blanch Point, × 7.
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Fig. 12— *Mauidrillia* sp. cf. *secta* Powell 1944, P33377, BC 1, × 5.
Fig. 13— Genus nov. ?, P33388, BC 3, × 10.
Fig. 14— *Conorbis atractoides* (Tate 1890), T750A, holotype, Adelaide Bore, × 5.
Fig. 15— *Conorbis atractoides otwayensis* subsp. nov. P42959, holotype, AW 1, × 4.

PLATE 7

Fig. 1— *Guraleus* sp. cf. *eocenicus* sp. nov., P33370, BC 1, × 10.
Fig. 2— *Guraleus eocenicus* sp. nov., P42871, holotype, BC 3, × 11.
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Fig. 4— ?*Antiguraleus* sp. c., P42941, AW 1, × 10.
Fig. 5— ?*Antiguraleus* sp. a., P42889, AW 1, × 10.
Fig. 6— *Macteola eocenica* sp. nov. P42874, holotype, BC 3, × 15.
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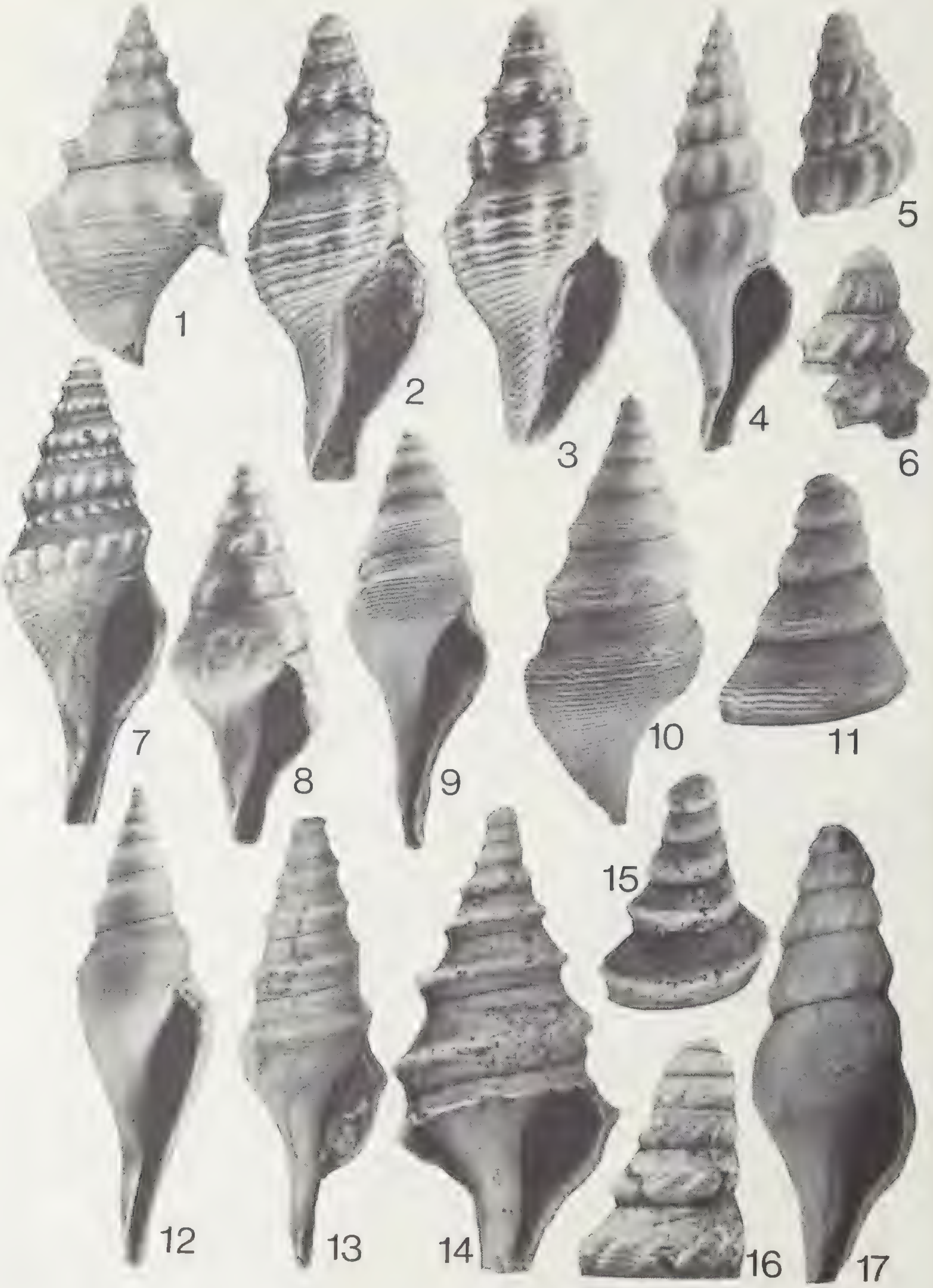
Fig. 17— *Parasyngenochilus angustior* gen. *et* sp. nov., P42961, holotype, AW 1, × 6.
Fig. 18— *Parasyngenochilus* sp. b., P42905, BC 3, × 5.
Fig. 19— *Mitra citharelloides* Tate 1899, T631B, holotype, Aldinga, × 7.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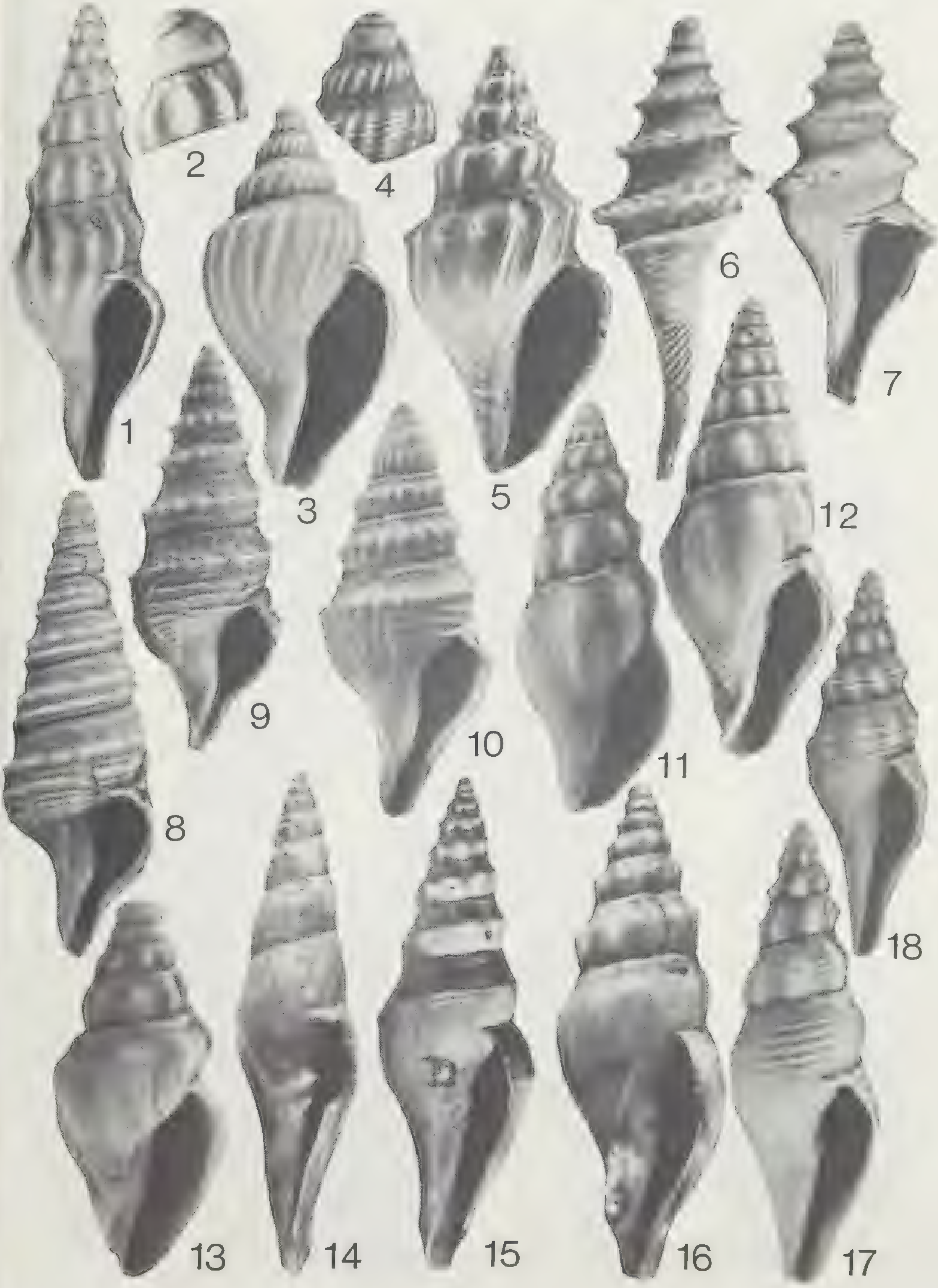
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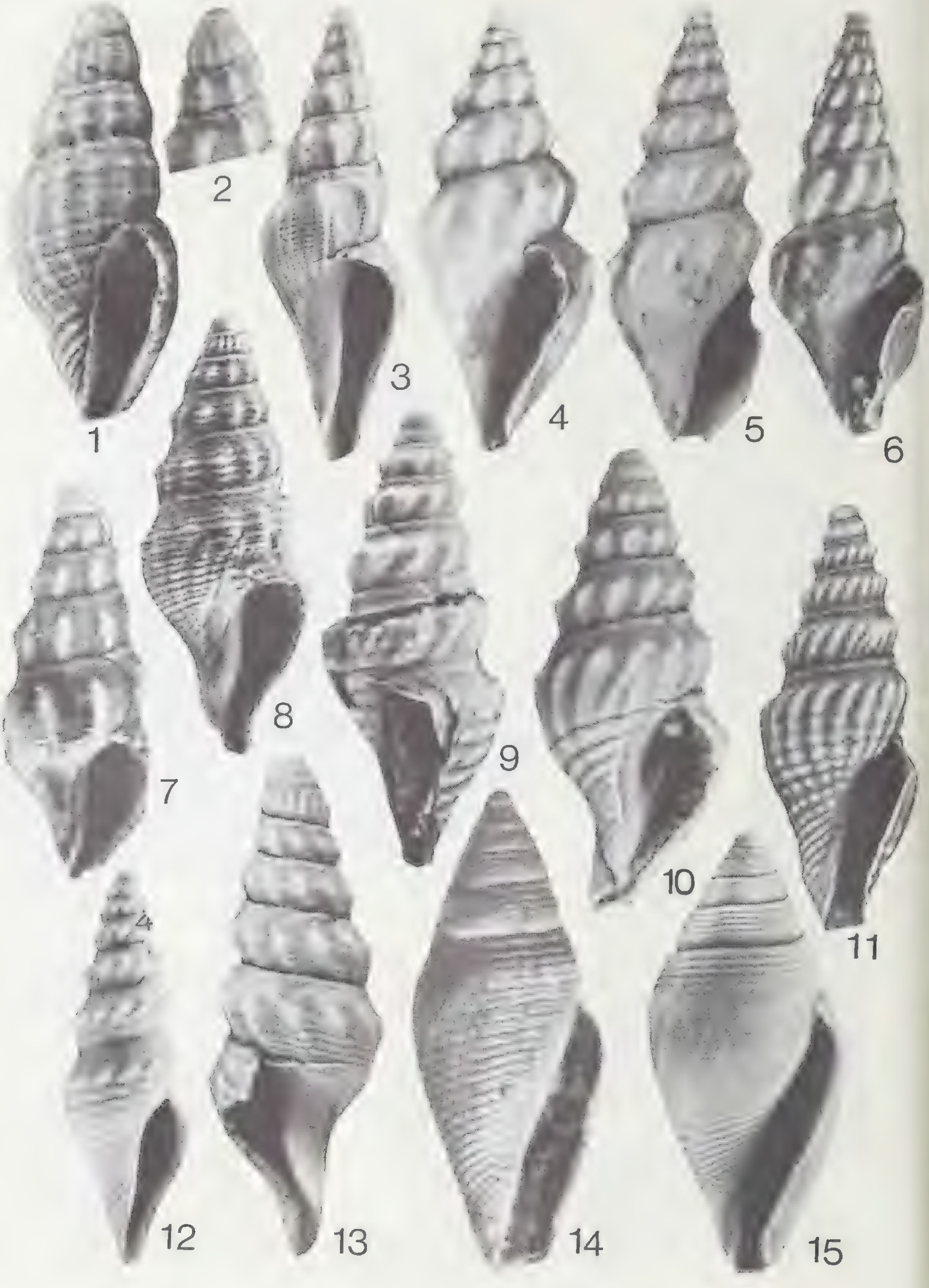
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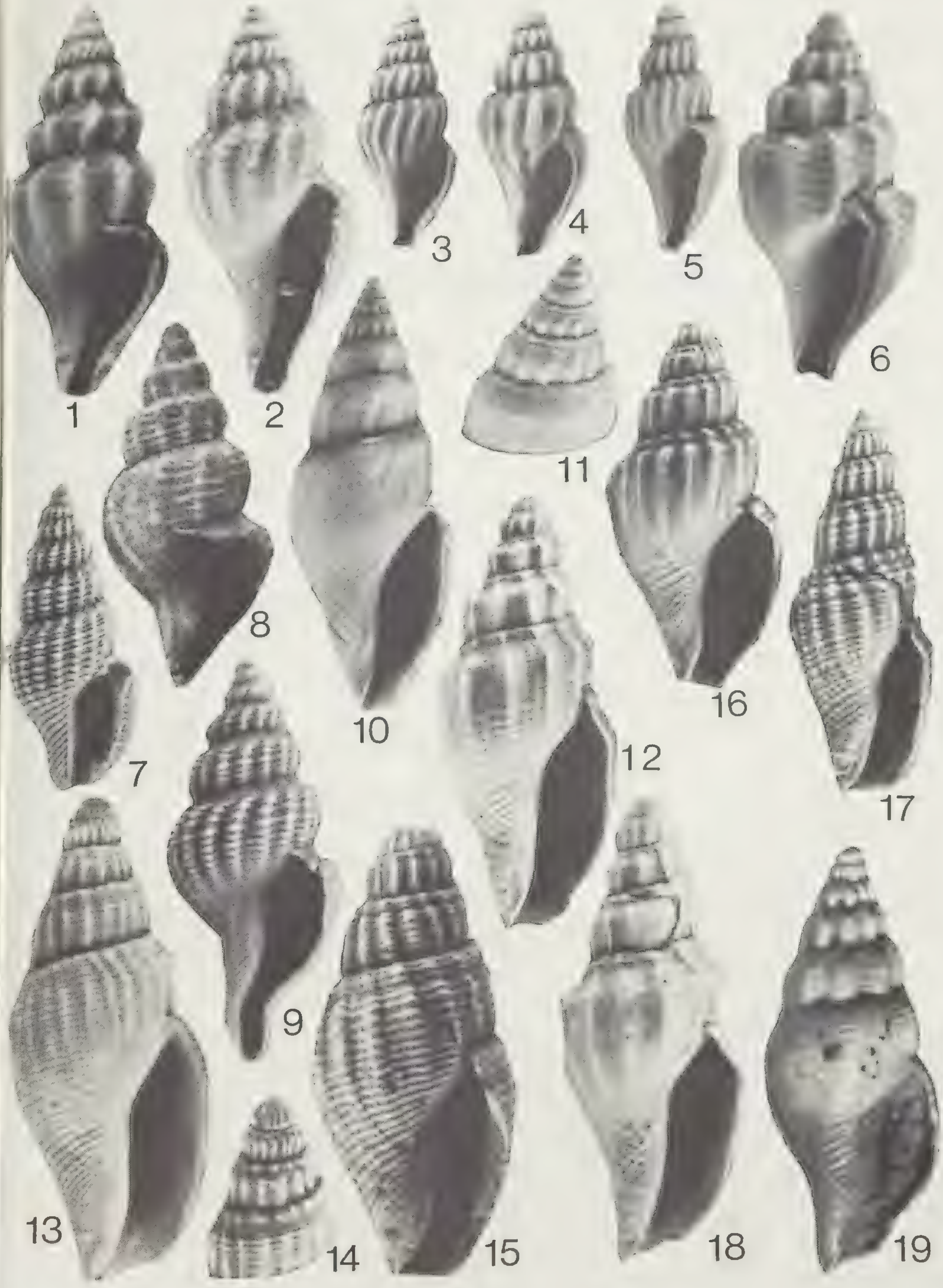
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PARANTHURID ISOPODS (CRUSTACEA, ISOPODA, ANTHURIDEA) FROM SOUTH EASTERN AUSTRALIA

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Abstract

Isopods of the family Paranthuridae from south-eastern Australia are described: *Accalathura gigas* (Whitelegge), *Accalathura bassi* n. sp., *Aenigmathura lactanea* Thomson, *Colanthura furneauxi* n. sp., *C. peroni* n. sp., *Leptanthura boweni* n. sp., *L. flindersi* n. sp., *L. murrayi* n. sp., and *Ulakanthura marlee* n. sp. Distinguishing features of *Accalathura gigantissima* Kussakin from Antarctica are noted.

Introduction

Large collections of isopods from marine benthos of the Victorian and New South Wales bays and shelf show that seven of the twelve genera of the family Paranthuridae diagnosed by Poore (1980) are represented. These are *Leptanthura, Bullowanthura* and *Ulakanthura,* which were dealt with in part by Poore (1978), and *Accalathura, Aenigmathura, Colanthura* and *Paranthura.* In this contribution additional species of *Leptanthura* and *Ulakanthura* and species belonging to *Accalathura, Aenigmathura* and *Colanthura* are described. The genus *Paranthura* will be the subject of a later study. A key and diagnoses for parathurid genera were given by Poore (1980).

In all the figures the following abbreviations are used: A1, A2, antennae 1 and 2; MD, mandible; MDp, mandibular palp; MP, maxilliped; P1-P7, pereopods 1 to 7; PL1-PL5, pleopods 1 to 5; T, telson; U, uropod; AM, appendix masculina.

Material for this study has come from the following surveys and institutions:

Crib Point Benthic Survey, 1965-1972 (CPBS) and Westernport Bay Environmental Study, 1973-1974 (WBES), both carried out in Western Port, Victoria, by the Marine Studies Group, Ministry for Conservation, Melbourne, Victoria;

Shelf Benthic Survey, 1973 (AMSBS) carried out on the New South Wales shelf by the Australian Museum, Sydney, N.S.W.;

Eurobodalla Shire Estuary Survey, 1974 (AMESES) carried out in southern N.S.W. by the Australian Museum, Sydney;

Hawkesbury River Study, 1977-1978 (AMHRS) carried out in the Hawkesbury River estuary by the Australian Museum, Sydney;

Surveys carried out in eastern Victorian estuaries by the LaTrobe Valley Water and Sewerage Board (LVWSB) in 1978-1980;

Australasian Antarctic Expedition, 1911-14 (AAE), and British, Australian and New Zealand Antarctic Research Expeditions (BANZARE);

The National Museum of Victoria (NMV), Melbourne, the Australian Museum (AM), Sydney, the South Australian Museum (SAM), Adelaide, and the Western Australian Museum (WAM), Perth.

Accalathura Barnard

Accalathura Barnard, 1925: 147.—Menzies & Glynn, 1968: 33.—Poore, 1980: 58-59.

Katanthura Nierstrasz, 1941: 243.

Metanthura Nierstrasz, 1941: 247.

Description: Paranthuridae with eyes (but sometimes lacking pigment). Pereon with feeble dorsolateral grooves, otherwise smooth; pereonites 4-6 with a small dorsal pit and sometimes with a transverse groove. Pleonites distinct from each other and from telson. Telson thin, narrow, not indurate and with long terminal setae; statocyst absent, or present and opening by a dorsal slit or pore. Uropodal endopod usually barely exceeding telson, richly setose; exopod usually narrow and lanceolate but rarely ovate, setose. Antenna 1 flagellum longer than peduncle, of 10-20 articles. Antenna 2 flagellum as long or longer than peduncle, of 10-30 articles. Mandible with an acute incisor, its palp with 3 articles, the last bearing a comb of about 20 setae. Maxilla a sharp, barely-serrate spine. Maxilliped elongate, the suture between head and basis clear; a prominent narrow endite reaching to the middle of

the second palp article; palp of 2 articles, the first with 3-5 setae and the second with many long terminal setae. Pereopod 1 stout, subchelate, palm with a setose cutting edge and usually a pronounced proximal thumb. Pereopods 2 and 3 subchelate, less well developed than first, article 6 flattened, ovate or linear, with 4-6 spines on cutting edge. Pereopods 4-7 with article 5 linear, anterior and posterior margins equal. Pleopod 1 exopod operculiform, only slightly indurate. Adult male only slightly more elongate than juvenile or female, bearing a multi-articulate flagellum on antenna 1 which bears fine aesthetascs most commonly only on the proximal half or two-thirds. Females with oostegites on pereonites 2-5. Colourless or with brown pigment dorsally and on some limbs.

Remarks: The genus *Accalathura* at present includes twelve species, most from the Indo-Pacific region (Poore, 1980). This description concurs with Barnard's (1925) and Poore's (1980) diagnoses in all except some minor points. Barnard noted only three pairs of oostegites; four are found on all Australian species as is the usual case for paranthurids. Eyes are present in all species as stated by Poore (1980) but are without pigment in *Accalathura gigas* and *A. gigantissima* where they may be seen only by dissection.

A redescription of the type species follows with notes on the related species *A. gigantissima* from Antarctica. A new species from south-eastern Australia is described and the possibility of a third in the region is raised.

Elsewhere in Australia the genus is represented by at least seven other species, probably undescribed. These are represented in museum collections by one or two individuals each and come from Thursday Island, Lizard Island (two species), Heron Island, the Coral Sea and Western Australia [two species including Thomson's (1951) record of *A. gigas*].

Accalathura gigas (Whitelegge)
Figures 1, 2

Calathura gigas Whitelegge, 1901: 225-229, figs 19a-e (Port Jackson, N.S.W., 66-71 m).
Accalathura gigas.—Barnard, 1925: 148 (part).— Nierstrasz, 1941: 242 (part).— Poore: 59 (part) [N.S.W.].
not *Accalathura gigas.*—Barnard, 1925: 148 (part).— Nierstrasz, 1941: 242 (part) [Seychelles]. = *A. sladeni* (Stebbing, 1910).
not *Accalathura gigas.*—Barnard, 1925: 148 (part).—Hale, 1929: 246.—Nierstrasz, 1941: 242 (part).—Poore, 1980: 59 (part) [St Vincent Gulf, South Australia]. = *A. bassi* n. sp.
not *Accalathura gigas.*—Barnard, 1936: 148.—Nierstrasz, 1941: 242 (part) [Arakan, Lower Burma]. Specific identity not determined.
not *Accalathura gigas.*—Hale, 1937: 14-15 (part).—Poore, 1980: 59 (part) [Antarctica]. = *A. gigantissima* Kussakin, 1967.
not *Accalathura gigas.*—Thomson, 1951: 2, fig. 1 [Rottnest Island, Western Australia] = *Accalathura* sp.
? *Accalathura gigas.*—Hale, 1937: 14-15 (part) [off Maria Island, Tasmania, 2380 m.].

Description: Female: Head as wide as long, about half as long as pereonite 1; rostrum about half length of lateral lobes; lateral lobes truncated but with rounded corners; eyes without pigment.

Pereon with shallow sharply-defined dorsolateral grooves, most obvious on pereonites 3 to 7; very shallow dorsal pits on anterior margins of pereonites 4 to 6. Pleon 1.5 times as long as pereonite 7.

Antenna 1 peduncle reaching to end of third article of antenna 2; flagellum of about 25 articles, reaching almost to end of flagellum of antenna 2 (less so in juveniles). Antenna 2 flagellum of 30-40 articles. Antennal flagella with fewer articles in juveniles.

Mandibular palp article 2 with 3-4 setae; article 3 more than twice as long as greatest width, with a comb of 30 spines and 1 long seta. Maxillipedal endite reaching to middle of second palp article, with 2 ventral setae; palp article 1 with 6 ventral setae, article 2 with many terminal setae.

Pereopod 1 stout; palm with a strong perpendicular thumb, an acute angle between its distal margin and the palm; palm and thumb with about 50 marginal setae. Pereopods 2 and 3 similar, article 6 ovate with 7-8 spines on cut-

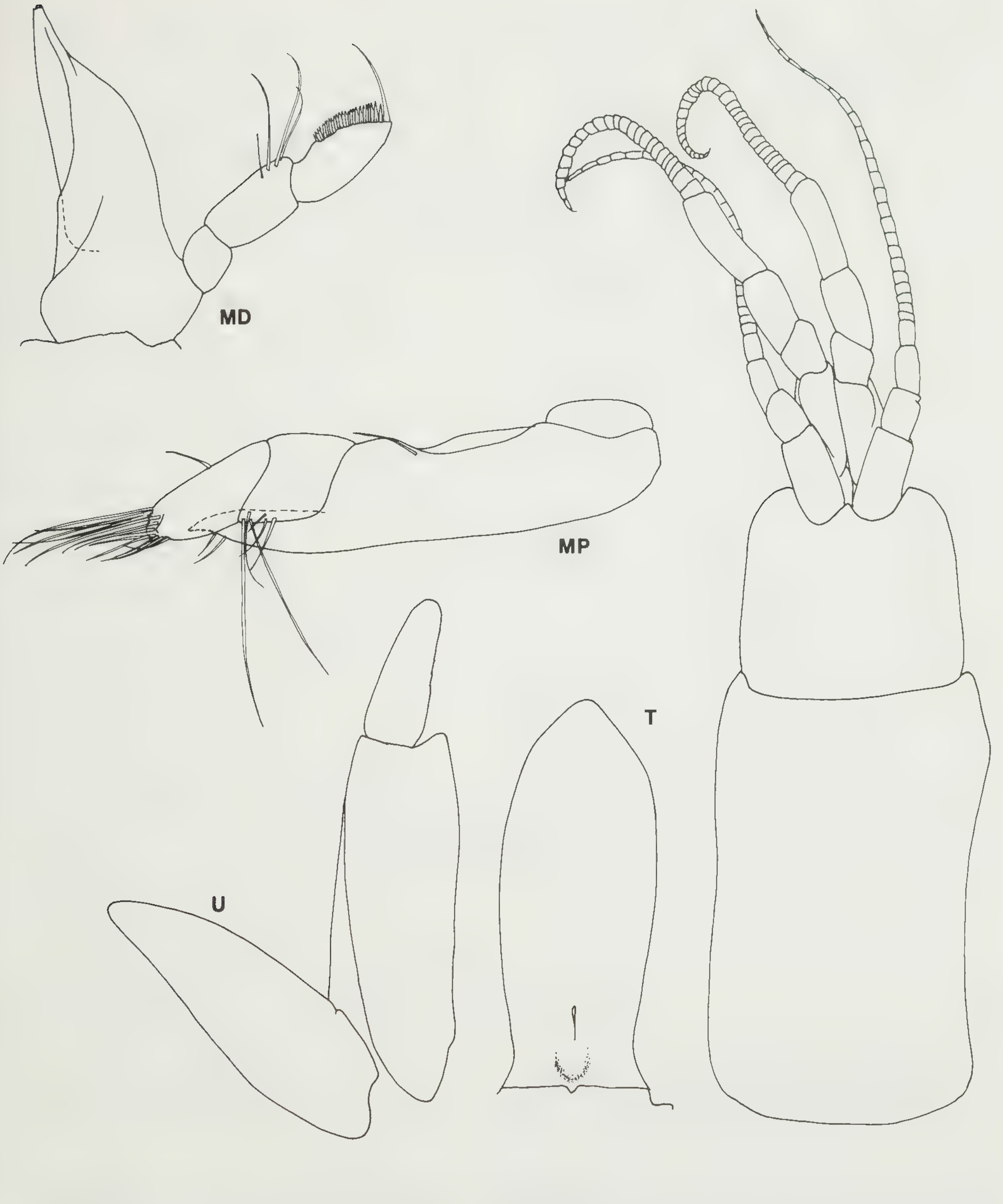

Figure 1—*Accalathura gigas*. Lectotype, juvenile, 39 mm (AM G2197).

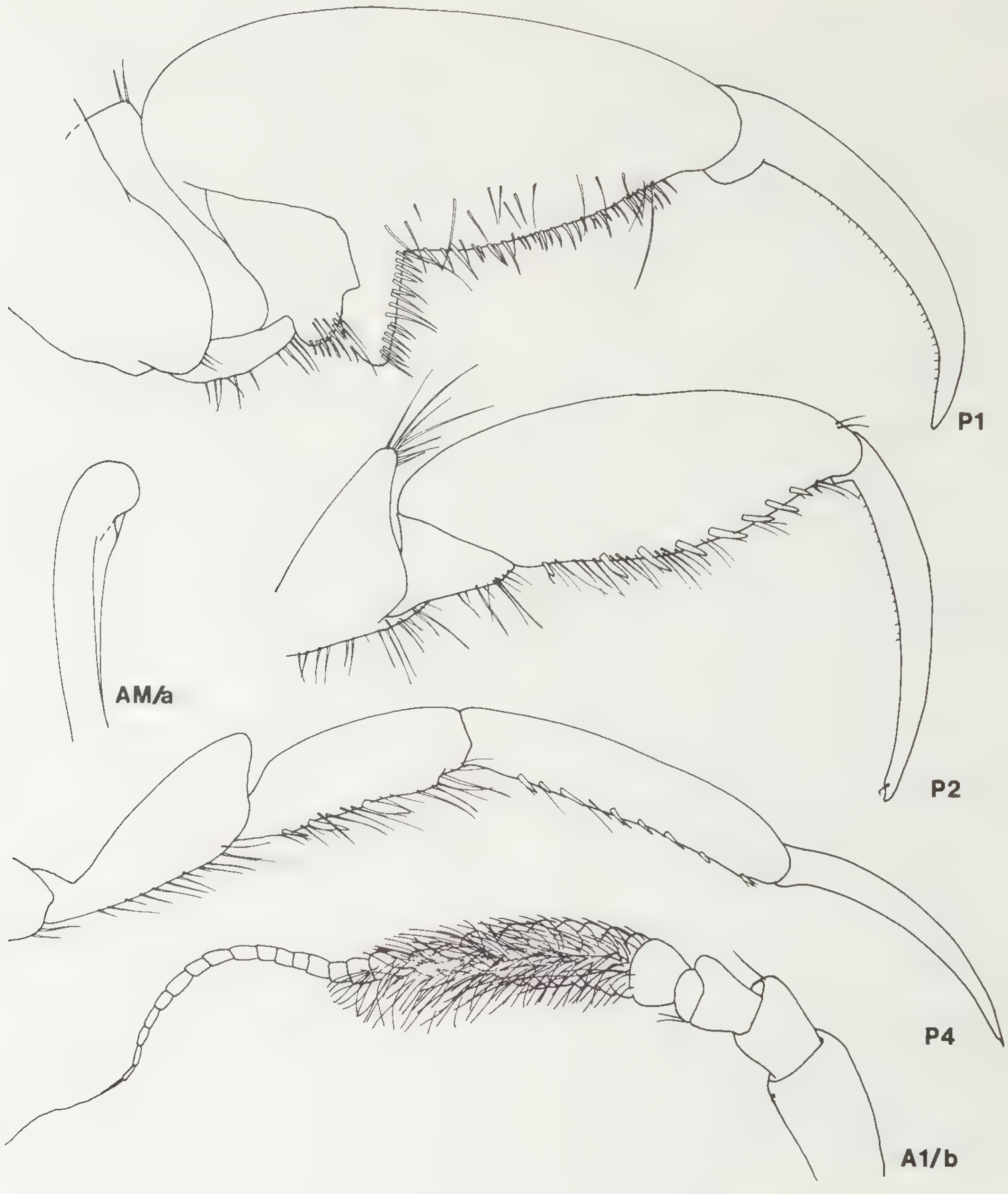

Figure 2—*Accalathura gigas*. Lectotype, juvenile, 39 mm (AM G2197); male, 42 mm (NMV J703); male, 42 mm (AM G2197).

ting edge. Pereopod 4 elongate, articles 5 and 6 with marginal spines; article 6 is 5 times as long as wide; article 7 about 11 times as long as width at midpoint and about 80% length of article 6. Pereopods 5-7 similar to 4 but more elongate.

Uropodal peduncle shorter than telson, distomedial angle acute; endopod length 2.5 times greatest width; exopod broadly lanceolate, length 3 times greatest width. Telson widest near its midpoint, broadly tapering to a subacute tip, length 2.5 times greatest width.

Pleopod 1 indurate and exopod operculiform. Coloured off-white.

Male: Antenna 1 flagellum with about 40 articles, only about half its length swollen and bearing aesthetascs. Perepods 1-3 with densely setose palms. Pereon ventrally rugose with transverse ridges on pereonites 2 to 6 and a ventral keel on pereonite 1. Appendix masculina about same length as endopod of pleopod 2, its tip slightly expanded, scooped.

Material examined: 3 males, 1 female, 50 juveniles; 10-42 mm.

Lectotype: Juvenile, 39 mm, AM G2197.

Type locality: Off Port Jackson, N.S.W., "Thetis" station 34, 66-71 m, March 1898.

Paralectotypes: Juvenile, 42 mm; male, 42 mm: from type locality, AM G2197.

Other material:
VICTORIA. Crib Point, Western Port, 8-19 m: CPBS stations 200(7), 21N(4), 21S(1), 22N(1), 22S(3), 300(3,3), 31N(1,2), 31S(3,1,1,1), 32N(1), 32S(1), 33N(1), 41N(1), 41S(2), 51S(1), 52N(3,3), NMV J687-707.

Western Port, 8 m: WBES station 1736(2), NMV J708.

N.S.W. 2 km E. of Long Bay, Sydney, 66 m: AMSBS station 24(2) AM P24355.

E. of Malabar, Sydney, 66-83 m: AMSBS station III(2) AM P22815; AMSBS station 40(1) AM P22817.

Distribution: Victoria (Western Port) and New South Wales shelf; 8-83 m.

Remarks: Accalathura gigas is distinguished from other south-eastern Australian species of the genus by its large size, lack of pigment, and its fine dactyls on posterior pereopods. Its affinities to *A. gigantissima* are noted in the next section. A lectotype is herein selected from Whitelegge's syntypes.

Accalathura gigantissima Kussakin
Figure 3

Accalathura gigantissima Kussakin, 1967: 253-256, figs 18, 19.—Poore, 1980: 59. [Lars Christensen Coast and North Coast, Antarctica].

Accalathura gigas.—Hale, 1937: 14-15 (part).—Poore, 1980: 59 (part) [George V land, Adelie Land and Shackleton Ice Shelf, Antarctica].

? *Accalathura gigas.*—Hale, 1937: 14-15 (part).—Poore, 1980: 59 (part) [off Maria Island, Tasmania, 2380 m].

Material examined: 3 males, 1 female, 17 juveniles, 13-51 mm.

Non-type material only:
ANTARCTICA. Off George V Land, 66°55′S, 145°21′E, 527-549 m, ooze, 28 Dec 1913, AAE station 2(5) SAM TC2486.

Off Adelie Land, 66°32′S, 141°39′E, 287 m, ooze, 31 Dec 1913, AAE station 3(3) SAM TC2484.

Off Shackleton Ice Shelf: 64°44′S, 97°28′E, 655 m, ooze, 31 Jan 1914, AAE station 11(1) SAM TC2487; 64°32′S, 97°20′E, 201 m, no ooze, animals and few rocks, 31 Jan 1914, AAE station 12(3) SAM TC2485.

Off Mawson Coast, 66°45′S, 62°03′E, 16 Feb 1931, BANZARE station 107: 123 m, SAM TC2489(4), 219 m, SAM TC2491(5).

Distribution: Antarctica; 123-655 m.

Remarks: Accalathura gigantissima is readily distinguished from *A. gigas,* with which it has been previously confused (Hale, 1937) by the broad rami of the uropod. Other differences are the much broader dactyls of pereopods 4-7, the very long appendix masculina with its dished end, and the male's smooth ventral pereon. These characters and the mandibular palp are figured for comparison with *A. gigas* (Fig. 3). Kussakin (1967) has adequately described this species in detail.

Hale's (1937) AAE collection included material from 1300 fathoms (1380 m) off Tasmania. Unfortunately, these specimens cannot now be found and it is therefore uncertain whether they belong to *A. gigas* or *A. gigantissima.* Although Hale noted differences in his material from the original description of *A. gigas* he did not differentiate the Tasmanian from the Antarctic specimens.

The BANZARE examples are new records for the species. A photograph of a specimen from the AAE collections was reproduced by Mawson (1915).

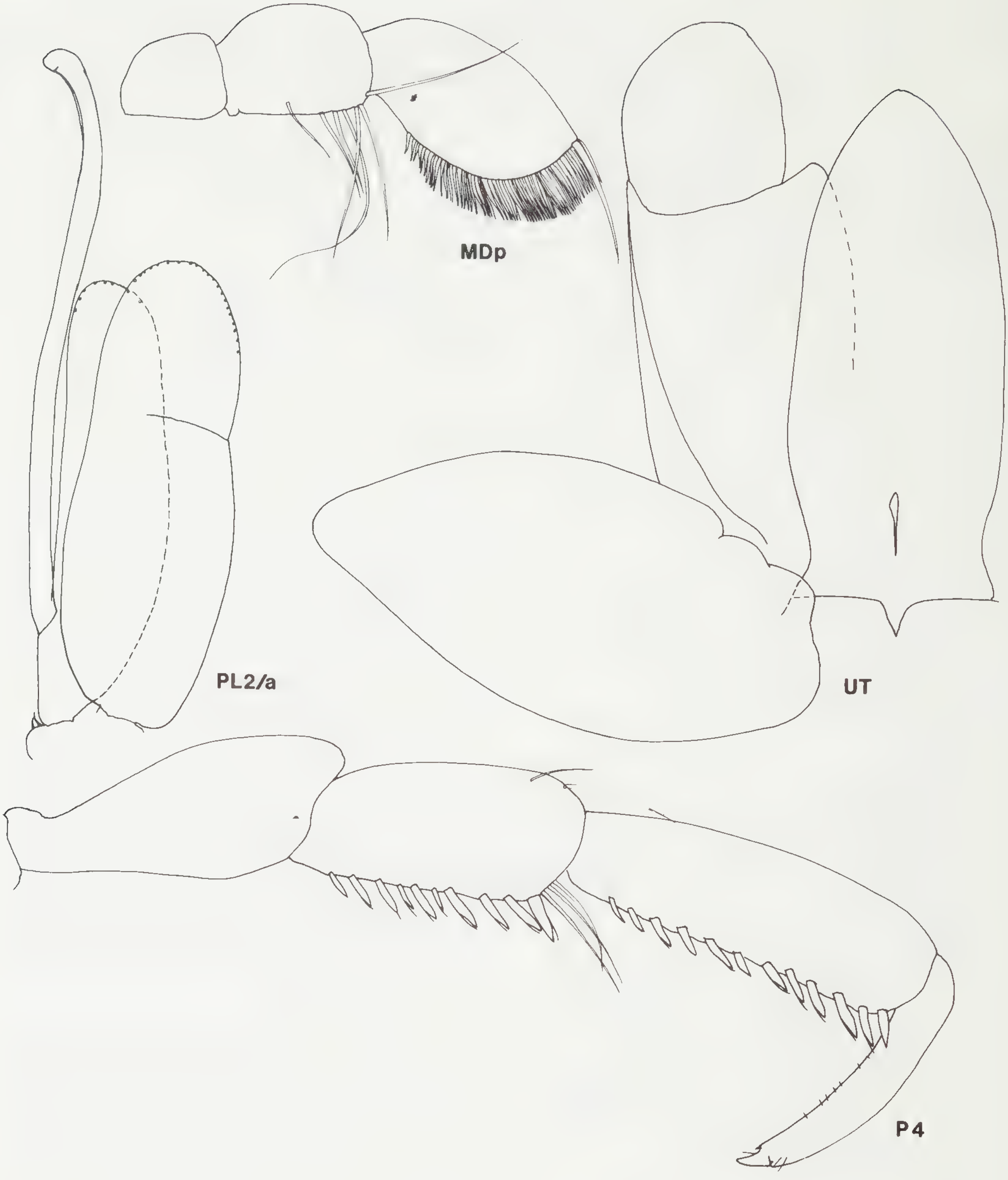

Figure 3—*Accalathura gigantissima*. Juvenile, 50 mm (SAM TC2484); male, 36 mm (SAM TC2485).

Accalathura bassi new species
Figures 4, 5

Accalathura gigas.—Barnard, 1925: 148.—Hale 1929: 246.—Nierstrasz, 1941: 242.—Poore, 1980: 59 [records, St Vincent Gulf, South Australia].

A. sladeni (Stebbing).—Hale, 1937: 14-15.—Kensley, 1980: 3-5 [records, South Australia].

not *Accalathura gigas* (Whitelegge, 1901).

Description: Female: Head as wide as long, little more than half as long as pereonite 1; lateral lobes rounded; eyes pigmented orange-red, 30-40 ommatidia, sometimes not contiguous in juveniles.

Pereon with poorly-defined dorsolateral grooves, most obvious on pereonites 3-7; transverse grooves on anterior margins of pereonites 4 to 6. Pleon 1.5 times as long as pereonite 7.

Antenna 1 peduncle reaching to end of second article of antenna 2; flagellum of 15-25 articles, reaching to midpoint of flagellum of antenna 2. Antenna 2 flagellum of 20-25 articles.

Mandibular palp article 2 with 2-4 setae; article 3 more than twice as long as greatest width, with a comb of about 20 spines and 1 long seta. Maxillipedal endite reaching to middle of second palp article, with 1 ventral seta; palp article 1 with 4-5 ventral setae, article 2 with many terminal setae.

Pereopod 1 stout; palm with a broadly-based thumb, a wide obtuse angle between its distal margin and the palm; palm and thumb together with numerous marginal setae. Pereopods 2 and 3 similar, article 6 ovate with 5-7 setae on cutting edge. Pereopod 4 moderately elongate, articles 5 and 6 with marginal spines; article 6 is 4 times as long as wide; article 7 about 7 times as long as width at midpoint and about 70% length of article 6. Pereopods 5-7 more elongate.

Uropodal peduncle much shorter than telson, distomedial angle projecting, acute; endopod length less than twice greatest width; exopod lanceolate, length 4 times greatest width. Telson widest near its base, broadly tapering to an acute or rounded tip, length 2.5 times greatest width. Pleopod 1 operculiform but not indurate.

Colour more or less well developed, brown patches dorsally on antennae, pereon, pleon, telson and uropods.

Male: Antenna 1 with about 25 flagellar articles, almost all swollen and bearing aesthetascs. Eyes of numerous contiguous ommatidia. Pereopods 1-3 with densely setose palms. Pereon ventrally smooth. Appendix masculina little longer than endopod of pleopod 2, its tip slightly curved, with a mesial blade.

Material examined: 2 males, 3 females, 35 juveniles: 9-23 mm.

Holotype: Ovigerous female, 21 mm, NMV J725.

Type locality:
VICTORIA. East Arm, Western Port, 38°22.28′S, 145°30.34′E, 5 m, sand, coll: Marine Studies Group, Ministry for Conservation, 29 Nov 1973 (WBES stn 1734).

Paratypes:
VICTORIA. Crib Point, Western Port, 8-19 m: CPBS stations 21N(1), 21S(3), 23N(2), 26S(1), 300(1), 31E(1), 32N(1,1), 32S(1), 33N(1), 41N(1), 41S(1), 42N(1), 51S(2), 52N(1) NMV J709-722, AM P30722.

Western Port, 9 m: WBES stations 1735 (2) NMV J724.

Western Port, off Rhyll, O.A. Sayce collection purchased 25.7.1911 (14) NMV J727.

Other material:
SOUTH AUSTRALIA. Cable Bay, coll: Dr Campbell, 13 Apr 1936. SAM TC 2494(1).

St Vincent Gulf (det. *A. gigas* by K. H. Barnard), SAM TC2503(1).

Port River, Adelaide, 4-9 m, coll: A. Zietz (det. *A. gigas* by K. H. Barnard), SAM TC2508(1).

Distribution: Victoria and South Australia; coastal waters, 8-19 m, sandy sediments.

Remarks: Accalathura bassi shows some points of variability which are important in evaluating specific characters in the genus. First, the eyes of most of the material from the Crib Point Benthic Survey showed non-contiguous ommatidia. This was not the case in adult specimens

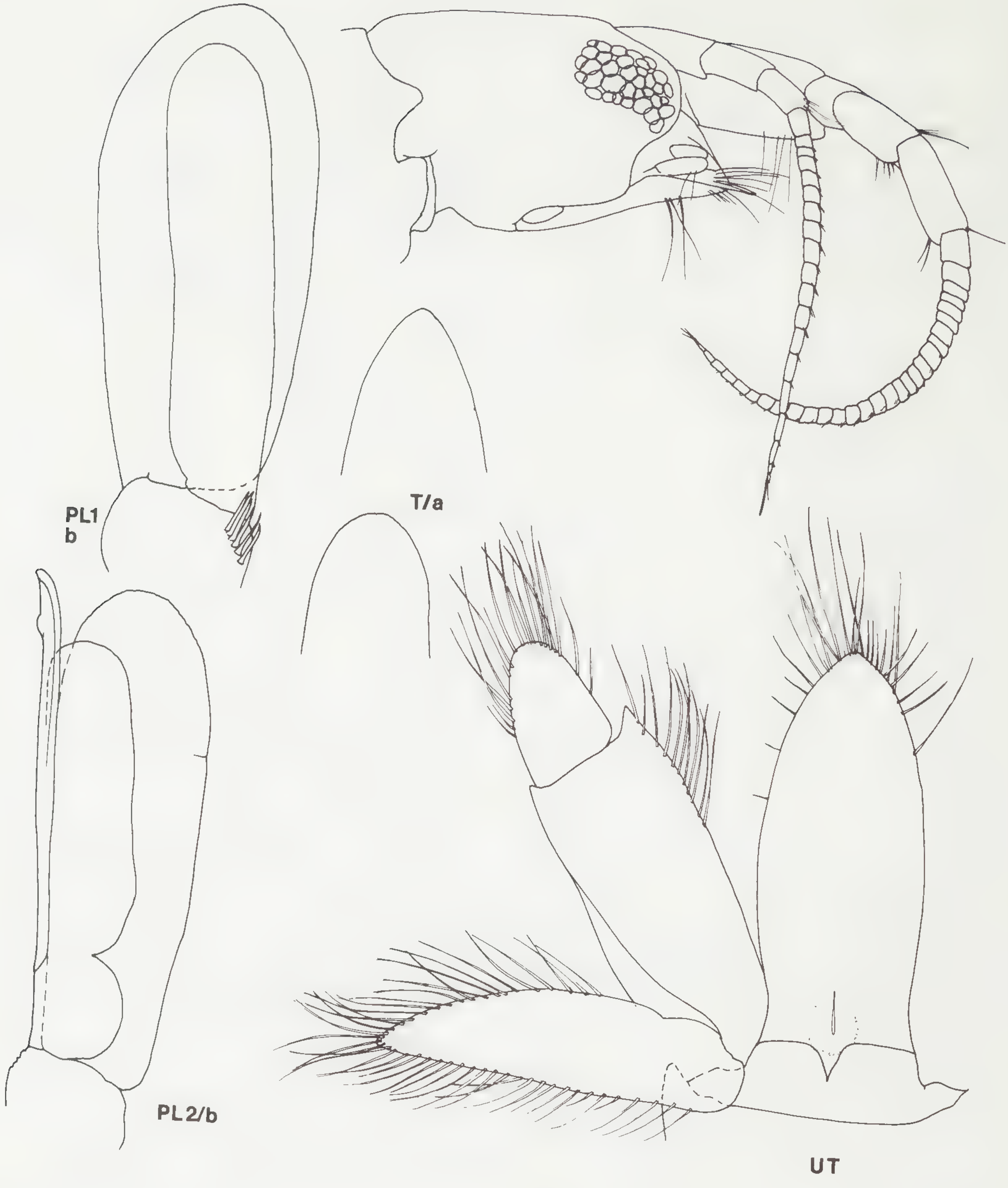

Figure 4—*Accalathura bassi.* Holotype, female, 21 mm (NMV J725); juveniles (NMV J727); male, 17 mm (AM P30722).

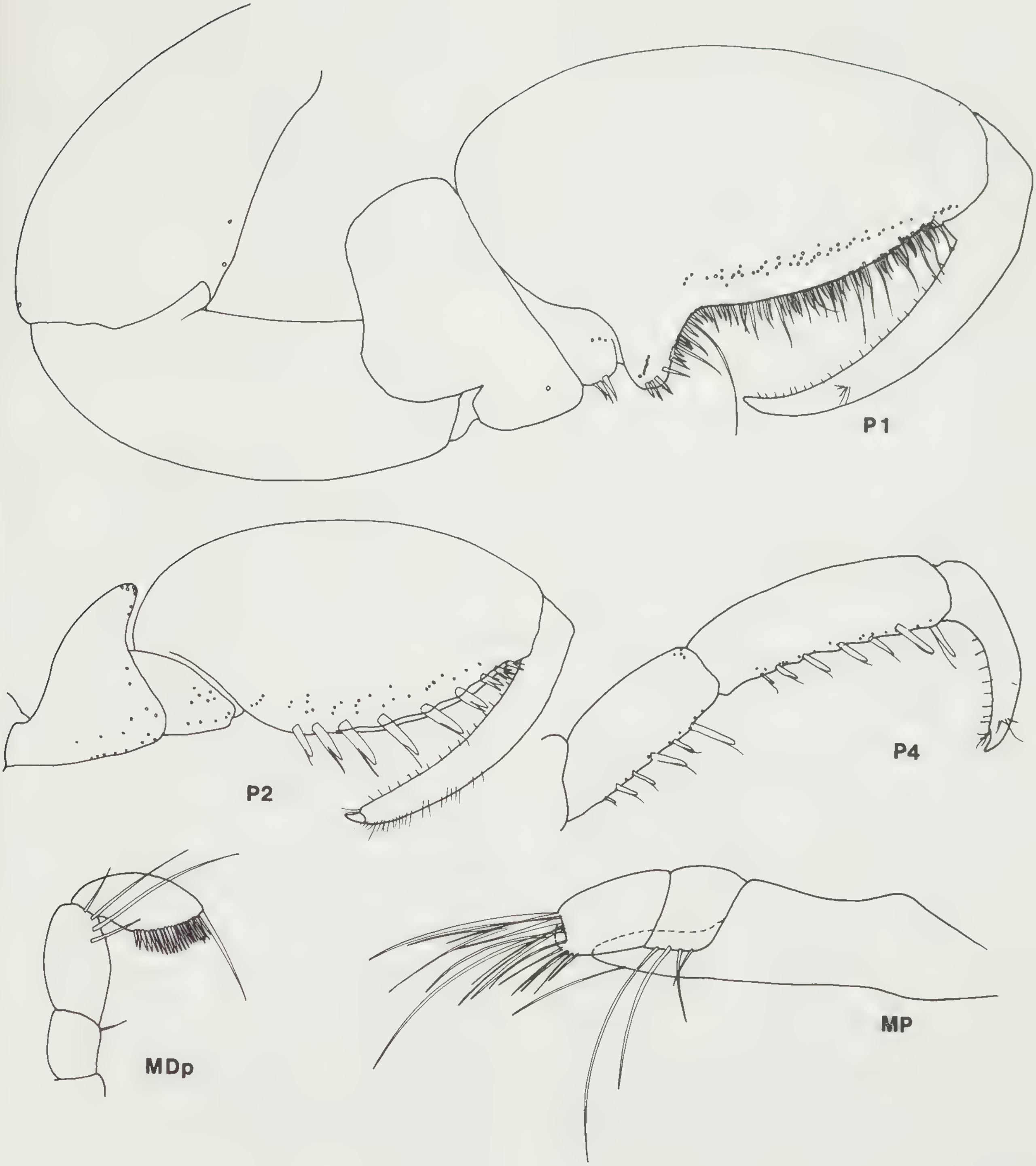

Figure 5—*Accalathura bassi.* Holotype, female, 21 mm (NMV J725).

nor in specimens with well-developed colouration. Both the nature of the eye and colour may be altered during preservation. (The CPBS material had spent at least 10 years in 5% formalin.) Second, the shape of the end of the telson varied from acute to rounded (Fig. 4) and seemed not to be associated with size or sex. Because of this variability it might have been possible to allocate the N.S.W. *Accalathura* sp. which follows, to *A. bassi* were it not for its distinctive male appendix masculina.

The material of *A. bassi* from South Australia has been assigned in the past to *A. sladeni* (Stebbing), a species originally described from the Indian Ocean. Barnard (1925) noted the similarity but at the same time synonomised the species with *A. gigas*; Hale (1937) revived *A. sladeni* for the South Australian specimens. There are, however, small differences between this Victorian and South Australian species and Stebbing's original figures. The dactyl of pereopod 1 and the sixth articles of pereopods 4-7 of *A. bassi* are broader than in *A. sladeni.* The maxillipedal and mandibular palps are more setose and the rami of the uropods and the telson are broader and less acute than in *A. sladeni.* In both species the appendix masculina has a simple apex, not bifid as figured by Kensley (1980) for other Indian Ocean specimens. Both species are close to a second Indian Ocean species, *A. borradailei* (Stebbing).

Accalathura sp.
Figure 6

Material examined: 1 male, 3 juveniles; 6-12 mm.

N.S.W. Port Kembla, epifauna, J. E. Watson, Feb 1977, NMV J726 (1 male).

Long Reef, Sydney, NMV J846(1).

E. of North Head, Sydney, 33°49'S, 151°18'E, 21.3 m, with the sponge *Polymastea craficia*, AMSBS station, AM P22811(1), AM P24361(1).

Distribution: New South Wales coast and shelf.

Remarks: The three juvenile specimens from N.S.W. could easily be assigned to the previous species *A. bassi* on the basis of similar colour pattern, mouthparts and pereopods. The telson is narrower than is usual for *A. bassi* from Victoria and South Australia but this character can be variable (compare Figs 4 and 6).

The distinctive appendix masculina of the male from Port Kembla (Fig. 6) and its smaller size would set this individual apart from the more southern species but the small number of specimens makes the status of the N.S.W. population uncertain. The telson and bifid appendix masculina is similar to those figured for Indian Ocean specimens of *A. sladeni* (Stebbing) by Kensley (1980).

Aenigmathura Thomson

Aenigmathura Thomson, 1950: 5-8.—Poore, 1980: 59-60.

Description: Paranthuridae with eyes. Pereon with feeble dorsolateral grooves, otherwise smooth; pereonites 4-6 with dorsal pits. Pleonites 1-5 fused together dorsally but with distinct epimera laterally, pleonite 6 free from others but fused to telson. Telson with a prominent proximal dome enclosing the statocyst which opens by a small dorsal pore. Uropodal endopod exceeding telson, exopod narrow. Antenna 1 flagellum rudimentary, of 3 articles. Antenna 2 flagellum of a single minute article. Mandible with an acute incisor, its palp of 3 articles, the last bearing a comb of about 10 setae. Maxilla a sharp barely-serrate spine. Maxilliped elongate, basis dintinct from head; a prominent endite reaching beyond the first palp article; palp of 2 (possibly 3) articles, the first with few setae and the second with many long terminal setae. Pereopod 1 stout, subchelate, palm with a spinose cutting edge and a strong proximal thumb. Pereopods 2 and 3 slightly less well-developed than first. Pereopods 4-7 with article 5 linear, anterior and posterior margins equal. Pleopod 1 operculiform, indurate. Adult male with more elongate pleon, uropods, pereopods than female or juvenile, bearing a multi-articulate flagellum with numerous aesthetascs on antenna 1. Females with oostegites on pereonites 3-5.

Remarks: The genus is monotypic. The description given above expands on that of Poore (1980) on the basis of the new material described below and the recently discovered type material.

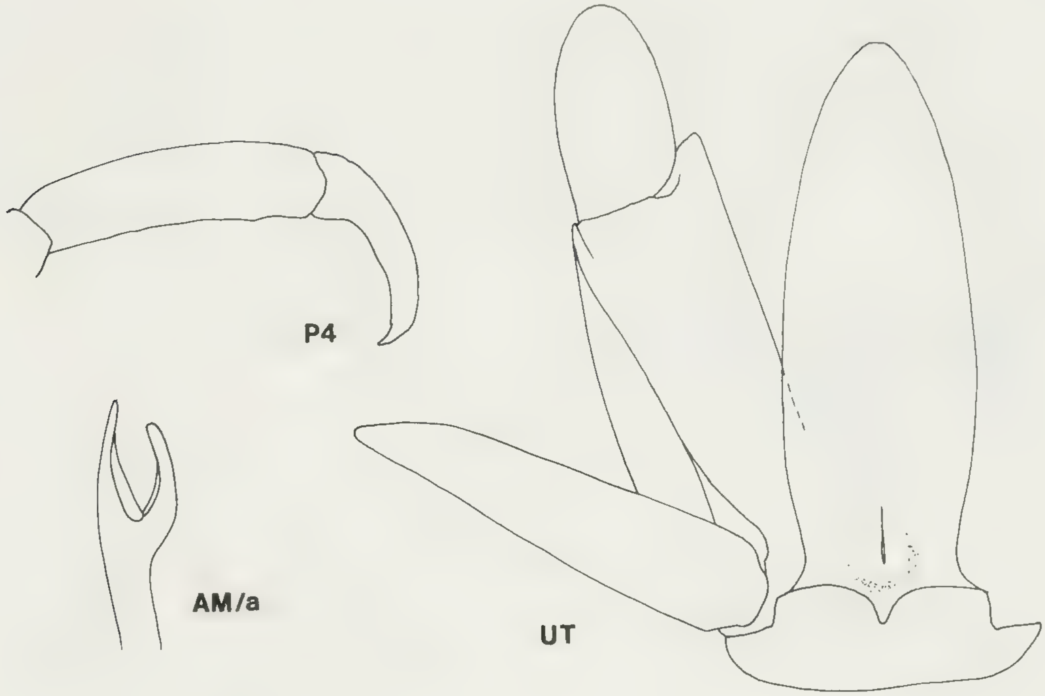

Figure 6—*Accalathura* sp. Juvenile, 12 mm (NMV J846); male, 12 mm (NMV J726).

Aenigmathura lactanea Thomson
Figures 7, 8

Aenigmathura lactanea Thomson, 1951: 5-8, figs 4a-k.

Description: Female: Head as wide as long, about two-thirds as long as pereonite 1; rostrum about half length of lateral lobes; lateral lobes rounded; eyes pigmented.

Pereon with dorsolateral rows of long setae; very shallow dorsal pits on pereonites 4 to 6. Pleon 1.5 times as long as pereonite 7.

Antenna 1 peduncle reaching to end of fourth article of antenna 2; flagellum of 2 articles, not reaching to end of peduncle of antenna 2. Antenna 2 flagellum of a single minute setose article.

Mandible with 2-4 setae near base of palp; palp article 2 longer than other two together, with 1-2 setae; article 3 twice as long as greatest width, with a comb of 9-10 spines. Maxillipedal endite pointed, reaching beyond first palp article, with 1 ventral seta; palp article 1 with 4 ventral setae, article 2 and poorly defined third article with 13-14 terminal and ventral setae.

Pereopod 1 stout; palm oblique, with a strong perpendicular thumb, the curved cutting edge of the palm is rolled laterally, its exposed medial surface complexly ridged; palm and thumb with 20-25 complex spines in the submarginal groove formed by the rolling of the cutting edge. Pereopods 2 and 3 similar, but little less well-developed. Pereopods 4-7 moderately elongate, article 5 about 1.5 times as long as wide, with 4-5 posterior spines; article 6 with 4-6 posterior spines; article 7 stout, shorter than article 6.

Uropodal peduncle shorter than telson, distomedial angle blunt; endopod length 1.5 times greatest width, setose; exopod lanceolate, length 3 times greatest width. Telson widest proximally, with a rounded to subacute end, length twice greatest width. Pleopod 1 indurate and exopod operculiform.

Colour off-white.

Male: Antenna 1 flagellum with about 13-15 articles all bearing aesthetascs. Pereopod 1 palm

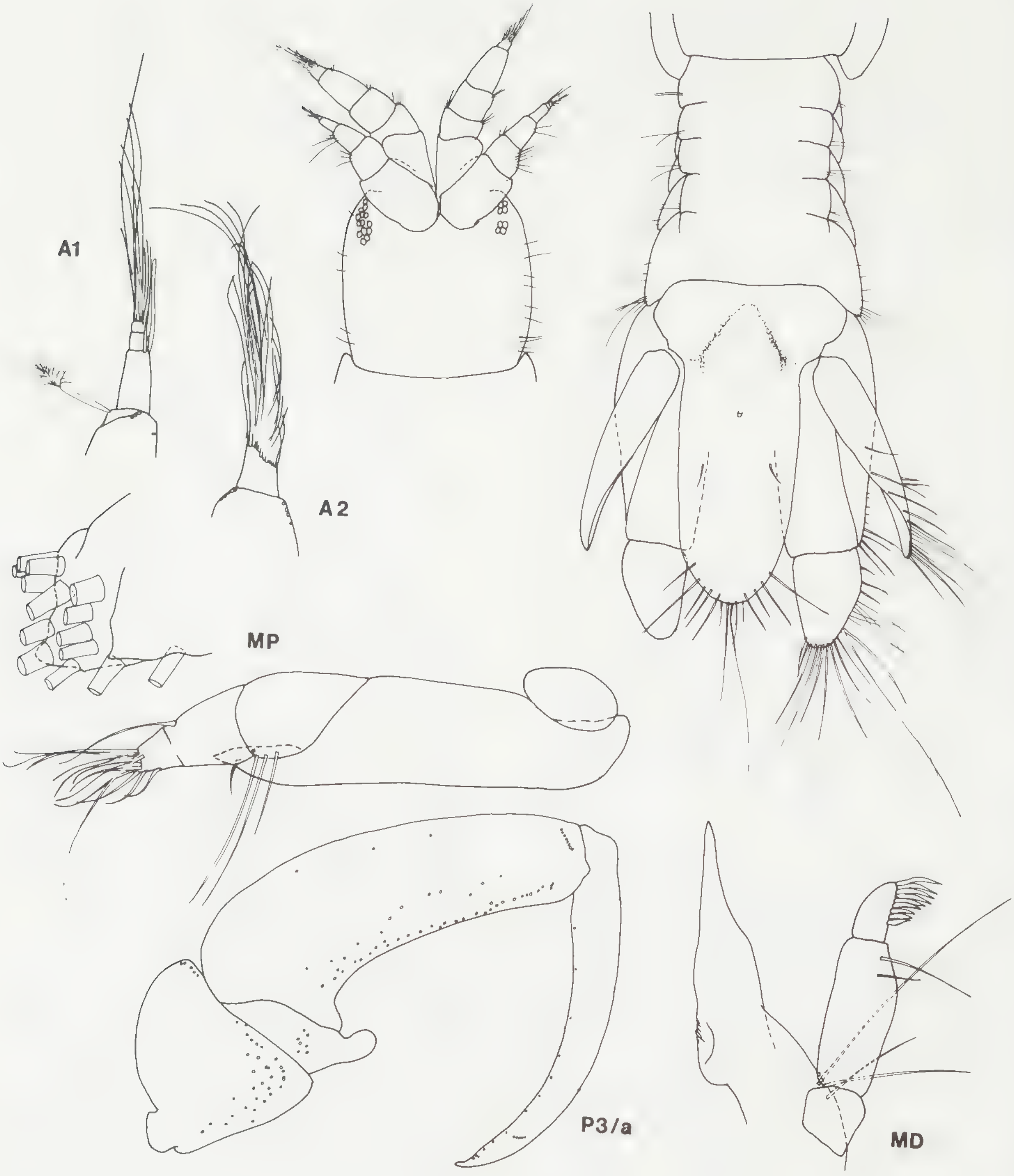

Figure 7—*Aenignathura lactanea*. Juvenile, 18 mm; male, 17 mm (NMV J851).

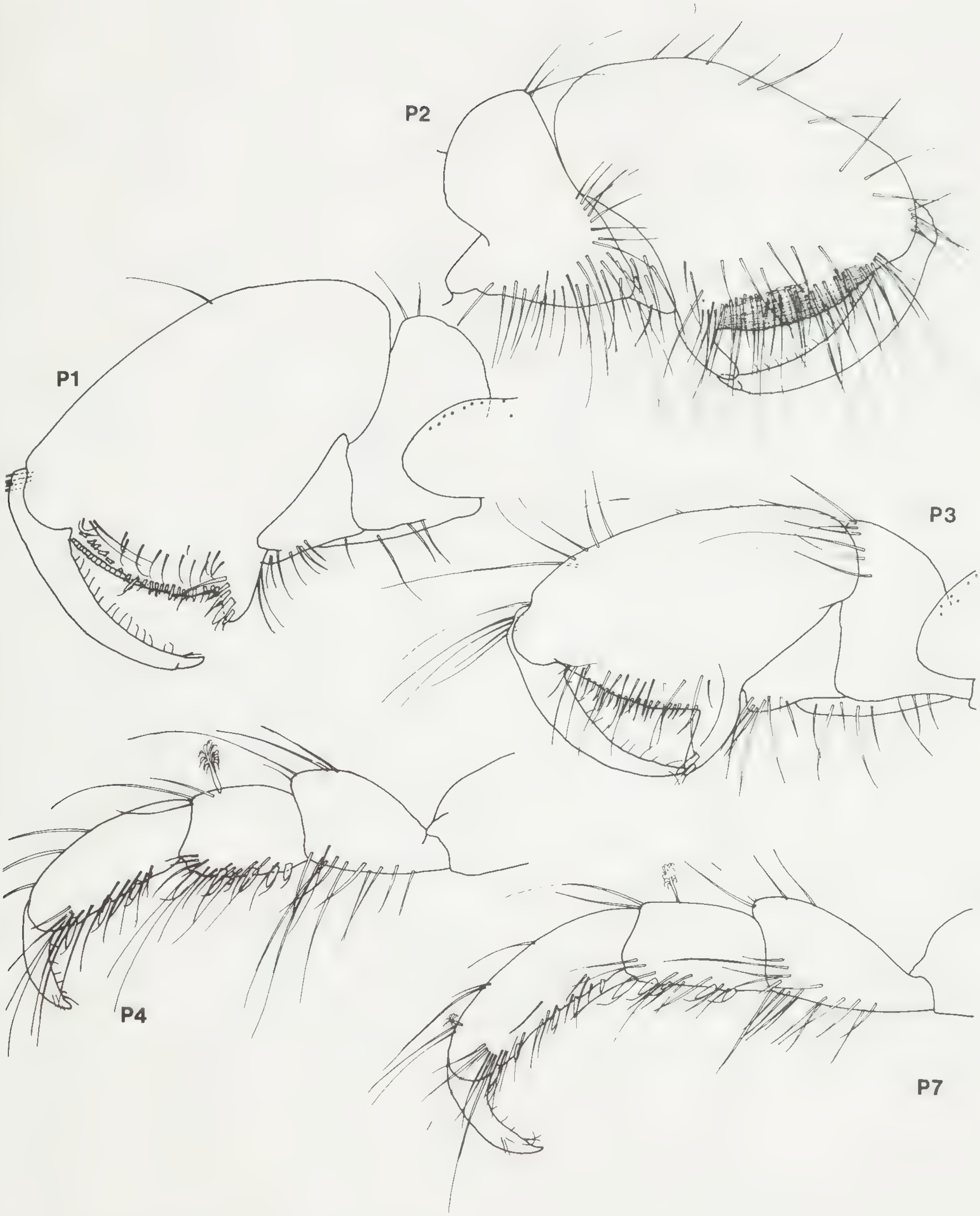

Figure 8—*Aenigmathura lactanea.* Juvenile, 18 mm (NMV J851).

axial-oblique, more elongate than in juveniles. Pereopods 2-3 with elongate concave densely setose palm, its proximal thumb dominated by a distal projection of article 5. Pereopods 4-7 more elongate than in juveniles. Pereon ventrally setose. Appendix masculina shorter than endopod of pleopod 2, its tip simple.

Material examined: 6 males, 3 females, 56 juveniles; 5.2-20.2 mm.

WESTERN AUSTRALIA. Bathurst Point, Rottnest Island, WAM 11/17-31(2); WAM 147-62 (syntype male and female).

VICTORIA. Crib Point, Western Port, 8-23 m: CPBS stations: C4(3), 21N(1), 23N(1), 300(7), 32N(2,1,6), 32S(5), 41N(13), 41S(1), 42S(1), 51N(4), 51S(8), 52N(3), 61N(4) NMV J847-860, AM P30721.

Western Port, 24 m: WBES station 1748(1) NMV J861.

Distribution: Victoria (Western Port) and Western Australia; intertidal—24 m.

Remarks: Thomson's (1951) figures and description adequately characterize the species but he failed to notice the fusion of pleonite 6 and telson, an unusual feature among paranthurids. The Victorian material differs from the type specimens from Western Australia only in that the apex of the telson is more acute.

Colanthura Richardson

Colanthura Richardson, 1902: 287.—Poore, 1980: 60-61.

Remarks: Colanthura is distinguished from other Australian paranthurids by the absence of the seventh pereopod in adults. Poore (1980) synonomised *Cruranthura* Thomson, represented by a single species from Western Australia with *Colanthura* on the basis of similar mouthparts, pereopods, pereon and tail fan.

In the type species of *Colanthura, C. tenuis* Richardson, all pleonites are free and pereonite 7 is much narrower and shorter than pereonite 6. This is the case also in *C. nigra* Nunomura, *C. pigmentata* Kensley, *C. uncinata* Kensley, *C. pingouin* Kensley, *C. squamosissima* Menzies and *C. uncinata* Kensley. In an undescribed species from the New Zealand subantarctic (Poore, in press) pereonite 7 and the pleon are similar in form to the type species but pleonites 1-5 are fused dorsally. In *C. simplicia* (Thomson), *C. caeca* Mezhov and in the two new species described here, pereonite 7 is as wide as and about one-quarter as long as pereonite 6. Only pleonites 1 and 6 are free from other pleonites; pleonites 2-5 are fused dorsally. *C. simplicia* and *C. peroni* n. sp. are also unusual in that pleopods 2-5 have a non-setose, 2-articled endopod, a condition rare elsewhere in the Anthuridea. But this is not so in *C. caeca* and *C. furneauxi* n. sp., the other two members of this group. The agreement in mandible, maxilliped and pereopods of all species of *Colanthura,* the scattered distribution of the two groups of species, and the variable form of the pleopods in the second group, argues against separate generic status for the last-mentioned four species.

Colanthura furneauxi new species
Figures 9-11

Description: Female: Head longer than wide, shorter than pereonite 1; rostrum broadly triangular, shorter than lateral lobes. Eyes dorsolateral. Pereonite 7 one-third the length of pereonite 6. Pereonites 4-6 with shallow, broad dorsal pits; all pereonites and pleon with sculpture of small pits laterally and dorsally. Pleon little longer than pereonite 6, pleonites 1 and 6 free from others, pleonites 2-5 fused only dorsally.

Antenna 1 flagellum of 4 articles, as long as last 2 articles of peduncle, with terminal setae and about 8 aesthetascs. Antenna 2 flagellum of 1 short article, only one-third as long as last article of peduncle, with numerous setae.

Mandible with a curved blade-like process mesially; palp absent. Maxilliped basis not distinct from head, bearing 1 ventral seta; maxillipedal palp not distinct from basis, with 12 ventral and terminal setae.

Pereopod 1 stout; article 5 with posterior setae; article 6 swollen, palm axial, convex and with a distinct truncate proximal thumb, palm with 2 rows of about 10 short setae laterally and one row of about 35 setae mesially. Pereopods 2, 3 less stout than 1; article 5 with setae; article 6 palm convex and with 6 marginal spines. Pereopods 4-6 similar; article 5 twice as long as

Figure 9—*Colanthura furneauxi*. Holotype, juvenile, 9.1 mm (NMV J1037, 1038).

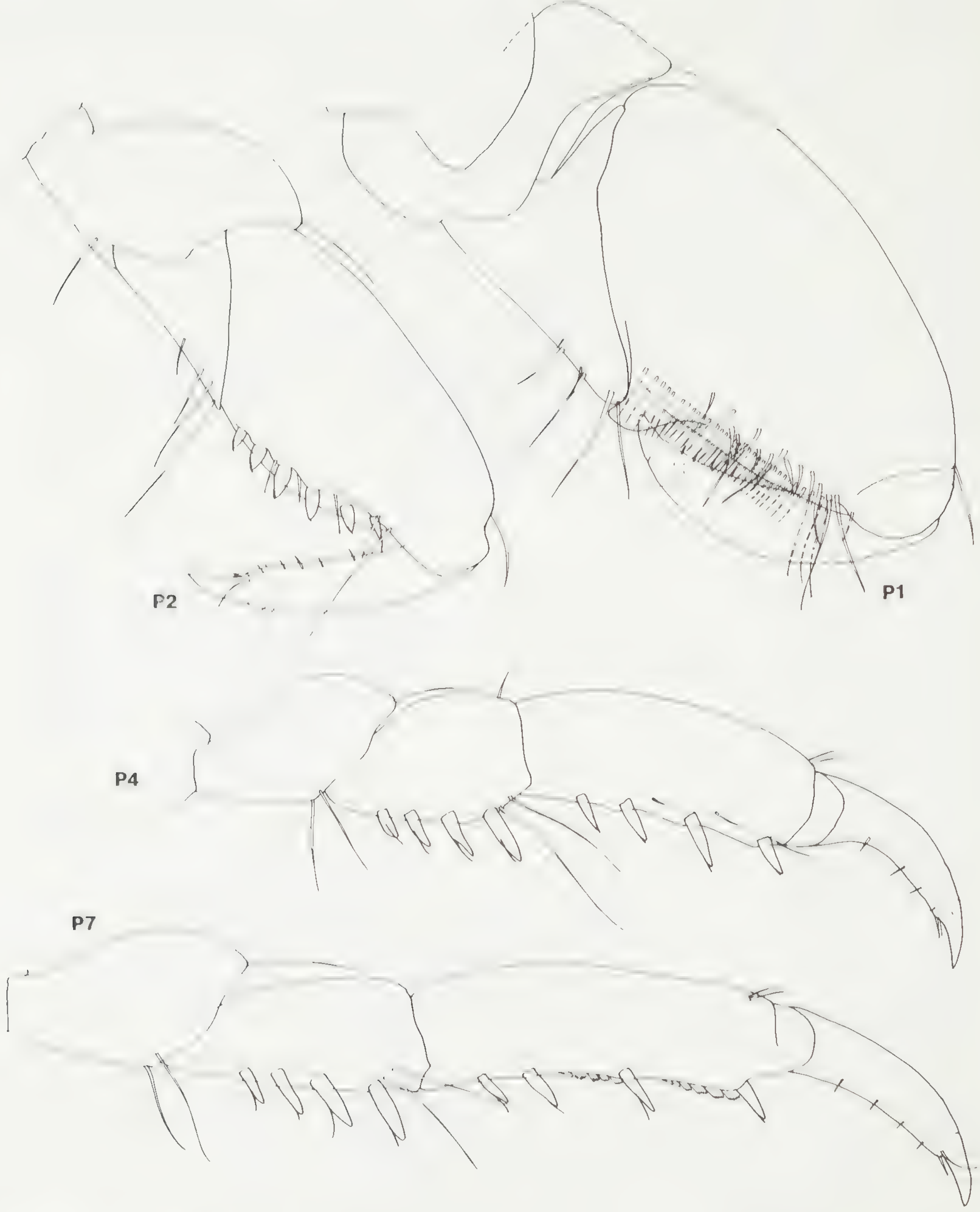

Figure 10 – *Colanthura furneauxi.* Holotype, juvenile, 9.1 mm (NMV J1037, 1038).

Figure 11—*Colanthura furneauxi.* Paratype, male, 5.5 mm (NMV J1040).

wide, with 4 posterior spines; article 6 is three times as long as wide, with 4 posterior spines; article 7 shorter than 6.

Uropodal peduncle with a subacute distomesial angle; endopod broadly ovate, wider than long, with convex margins, setose, half length of peduncle; exopod 1.4 times as long as wide, broadly excavate at apex, setose. Telson as long as uropod, dorsally concave, widest at midpoint, apex rounded, numerous terminal setae; no statocyst.

Pleopod 1 exopod operculiform. Pleopods 2-5 with terminal setae on both rami.

Colour densely red-brown on head, pereon and pleon, less obvious in some specimens.

Male: Differs from above description in flagellum of antenna 1 being of 5 articles bearing numerous aesthetascs, reaching to midpoint of head; appendix masculina straight, tip with minute terminal hook, longer than exopod.

Material examined: 4 males, 8 juveniles; 5.2-9.1 mm.

Holotype: juvenile, 9.1 mm, NMV J1037 and J1038 (slide).

Type locality:
Tasmania. Fisher Island, 2 m, on the alga *Caulocystis,* coll: G. Edgar, 1 Aug 1980.

Paratypes:
TASMANIA. Fancy Point, Bruny Island, 3-6 m, from algae, coll: G. Edgar, 9 June 1978-3 Jan 1979, NMV J1039 (1), J1040 (4), J1041 (2), J1042 (3).

Tinderbox, from the alga *Caulerpa,* coll: G. Edgar, 10 May 1978, NMV J1043 (1).

Distribution: Tasmania; subtidal.

Remarks: Colanthura furneauxi falls in the group of species in which pereonite 7 is as wide as and about one-quarter as long as pereonite 6 and in which pleonites 2-5 are fused dorsally. It differs from *C. peroni* n. sp. in possessing setae on both rami of the pleopods. The species may also be distinguished from *C. peroni* by the broader uropodal exopod.

C. furneauxi is most closely related to *C. caeca* Mezhov in the number of articles in the antennae and form of the pleopods, uropod and telson. The species differ in nature of the pereopods and uropodal exopod.

Colanthura peroni new species
Figures 12, 13

Description: Female: Head longer than wide, shorter than pereonite 1; rostrum broadly truncate, shorter than lateral lobes. Eyes dorsolateral. Pereonite 7 one-quarter the length of pereonite 6. Pereonites 3-6 with shallow dorsal pits. Pleon as long as pereonite 6, pleonites 1 and 6 free from others, pleonites 2-5 fused only dorsally.

Antenna 1 flagellum of 4 articles, as long as last 2 articles of peduncle, with setae and 2 or 3

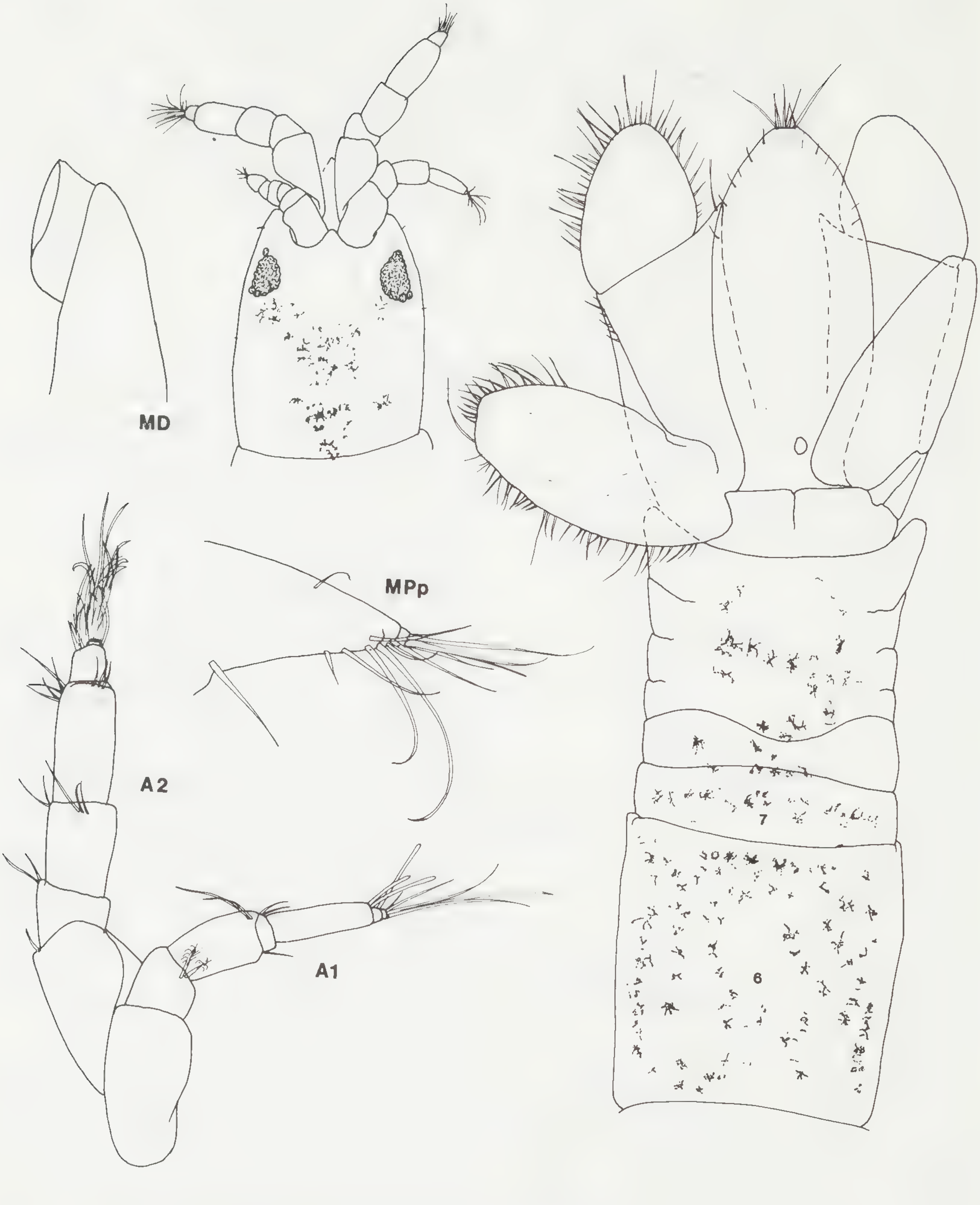

Figure 12—*Colanthura peroni.* Holotype, female, 9.5 mm (AM P24949).

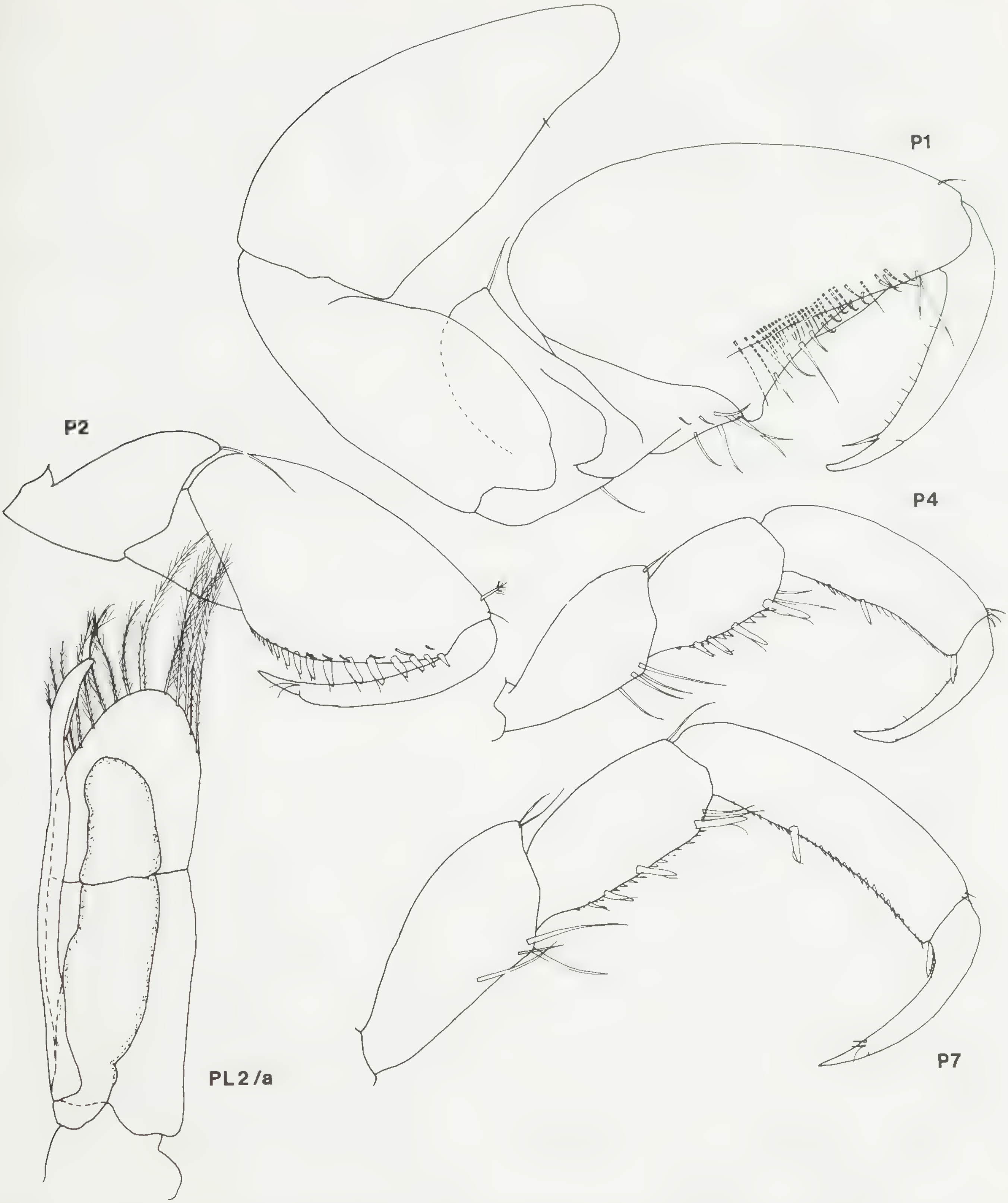

Figure 13 – *Colanthura peroni*. Holotype, female, 9.5 mm (AM P24949); male, 7.3 mm (AM P24950).

aesthetascs. Antenna 2 flagellum of 3 short articles, only one-third as long as last article of peduncle, with numerous setae.

Mandible with a curved blade-like process mesially; palp absent. Maxilliped basis not distinct from head, bearing 1 ventral and 1 distal setae; maxillipedal palp not dintinct from basis, only a minute terminal article partially free, palp articles together with 11 ventral and 1 dorsal setae.

Pereopod 1 stout; article 5 with posterior setae; article 6 swollen, palm axial, concave and with an obsolete proximal thumb, with about 12 short setae laterally and about 25 setae mesially. Pereopods 2, 3 less stout than 1; article 5 with setae; article 6 palm convex and with 10-12 marginal spines. Pereopods 4-6 similar; article 5 twice as long as wide, with 4 posterior spines; article 6 is 4 times as long as wide, with 1 distal spine and 1 one-third way along; article 7 shorter than 6.

Uropodal peduncle with an acute distomesial angle; endopod broadly ovate, almost as wide as long, with convex margins, setose, half length of peduncle; exopod twice as long as wide, truncate at apex, setose. Telson little shorter than uropod, dorsally concave, widest at midpoint, apex rounded, 10 terminal setae, about 12 submarginal setae in distal third; no statocyst.

Pleopod 1 exopod operculiform. Pleopods 2-5 without terminal setae on the endopod.

Colour red-brown in distinct chromatophores dorsally on head, pereon, pleon and telson.

Oostegites on pereonites 2-5.

Male: Differs from above description in flagellum of antenna 1 being of 4-5 articles bearing numerous aesthetascs, reaching to end of head; distomesial angle of uropod peduncle strongly produced; appendix masculina curved, slightly swollen tip, longer then exopod.

Material examined: 7 males, 5 females, 13 juveniles; 4.5-12.9 mm.

Holotype: Female, 9.5 mm, AM P24949.

Type locality:
N.S.W. Tuross River, 36°04.73′S., 150°07.43′E., low tide transect, AMESES stn 038, coll: N. Carrick, 7 Aug 1974.

Paratypes:
N.S.W. Brobothalle Bay, Tuross River, AMESES stn 064, AM P20899(1), AM P24951(2), AM P24953(3); stn 038, NMV J966(1).

Coila Lake, AMESES stn 029, AM P24950(1).

Near Juno Head, Hawkesbury River, 10 m, AMHRS stn 1.4, NMV J968(1).

Hawkesbury River, 20 m, AMHRS stn 9.1, AM P28606(1), AM P28607(1); AMHRS stn 10.2, NMV J967(1).

Other material:
VICTORIA. Wallagaraugh River, Mallacoota Inlet, LVWSB stn 53, NMV J971(2).

Snowy River estuary, near Marlo, LVWSB stn 44, NMV J970(10).

Distribution: N.S.W. and eastern Victorian estuaries; intertidal to 20 m.

Remarks: Colanthura peroni is most closely related to *C. simplicia* from Western Australia. Although type material of this species cannot be found, Thomson's (1946) figures indicate sufficient differences to warrant separate species status. The rami of the uropods of *C. simplicia* are proportionally much narrower than in *C. peroni.*

Leptanthura Sars

Leptanthura Sars, 1899: 47-48.—Poore, 1978: 136.—Poore, 1980: 61-62.

Remarks: A recent description (Poore, 1978) and a brief diagnosis (Poore, 1980) have been given for this genus. Poore (1978) described three species then known from south-eastern Australia [*L. diemenensis* (Haswell), *L. nunana* Poore and *L. kapala* Poore]; three further species are added here. *Leptanthura diemenensis* is the most common species in this part of Australia and typically is separated from others by the dished telson with a pair of long subterminal setae dorsally. There is still some confusion over the identity of several small specimens from shelf and slope of eastern Australia; these are not included in this paper.

Leptanthura boweni new species

Figures 14-16

Description: Female: Head wider than long,

little shorter than pereonite 1; rostrum truncate, as long as subquadrate lateral lobes; eyes absent. Pereonite 1 with strong lateral ridges produced anteriorly alongside head and laterally over articulation of pereopods, ridges less well defined on pereonites 2 and 3. Pereonites 4-6 with dorsal pits, and laterally a regular sculpture of minute pitting. Pleon more than twice as long as pereonite 7.

Antenna 1 flagellum of 2 articles, shorter than last article of peduncle, with 2 setae and 3 aesthetascs. Antenna 2 flagellum of 2-3 articles, as long as last article of peduncle, with about 20 setae.

Mandible with an acute incisor; palp articles 1 and 2 without setae, article 3 with a small terminal spine. Maxilliped basis not distinct from head, bearing 1 ventral seta distally; maxillipedal palp of 3 partially separated articles; article 1 with 3 ventral and 1 dorsal setae, article 2 with 1 or 2 setae and article 3 with 4 terminal setae.

Pereopod 1 with a stout basis; article 4 with a strong anterior lobe; article 5 with a produced distal margin bearing 1 terminal spine and seta; article 6 not swollen, palm well separated from distal corner of article 5, palm transverse and almost chelate, with 1 spine and medial setae; article 7 twice as long as palm. Pereopods 2, 3 like 1 but basis less stout, palm with 2 spines. Pereopods 4-7 similar; articles 5 and 6 each with 1 distal spine; article 7 as long as 6.

Uropodal peduncle produced distomesially, a high crest along its dorsolateral margin; endopod triangular but concave on mesial edge, setose, three-quarters length of peduncle; exopod deeply incised, setose, wider than long, ventral part acute, dorsal part more rounded although anterior margin straight. Telson shorter than uropod, dorsally concave, widest three-quarters way along and tapering to a subacute end; 4 short setae in a shallow terminal notch, few minute submarginal setae elsewhere.

Pleopod 1 exopod operculiform.

Oostegites on pereonites 2-6.

Male: As above description but: antenna 1 flagellum of 8-11 setose articles reaching to middle of pereonite 1; antenna 2 flagellum with 4 articles; pereopod 1 with long mesial setae on articles 4-6, no spine on article 6; pereopods 2, 3, palm poorly defined, posterior margins of article 6 with 4 spines; pereopods 4-7 more elongate; uropod rami more elongate; appendix masculina acute, tapering, reaching a quarter its length beyond endopod of pleopod 2.

Material examined: 4 males, 21 females, 89 juveniles; 4.0-6.1 mm.

Holotype: Juvenile, 6.0 mm, NMV J932 and J933 (slide).

Type locality:
VICTORIA. Port Phillip Bay, 38°02.3'S., 144°44.7'E., 13 m, sand, coll: Marine Pollution Studies Group, 10 June 1971 (PPBES station 922).

Paratypes:
VICTORIA. Port Phillip Bay, 3-15 m: PPBES stations: 907(4), 908(4), 913(36), 922(10,13), 930(4), 932(7), 953(1), 984(2), 985(16) NMV J934-946, AM P 30723.

Other material: VICTORIA. Port Phillip Bay: PPBES stations: 1252(1), 1262(1) NMV J947-948.

Crib Point, Western Port, 7-19 m: CPBS stations: B1(1), 52N(1) NMV J949-950.

Western Port, intertidal to 18 m: WBES stations: 1704(1), 1707(2), 1724(2), NMV J951-953.

Flinders Canyon, eastern Bass Strait, 39°40.3'S., 148°46.5'E., 293-329 m, VIMS Cruise 79-K-1, HMAS "Kimbla", station 33, 27 Mar 1979, NMV J962(1).

N.S.W. Gunnamatta Bay, Port Hacking: NMV J954(3), NMV J955(1).

Distribution: Victoria and New South Wales bays; sandy to silty-sand sediments; intertidal-329 metres.

Remarks: Leptanthura boweni is an unusual species, perhaps worthy of separate generic status. It differs from all other species of *Leptanthura* in the poor development of the first three pereopods. The sixth article of these limbs is little stronger than those of the posterior walking legs and bears a peculiar transverse, almost chelate, palm. The broad dorsum on pereonite 1 is also not found elsewhere in the genus.

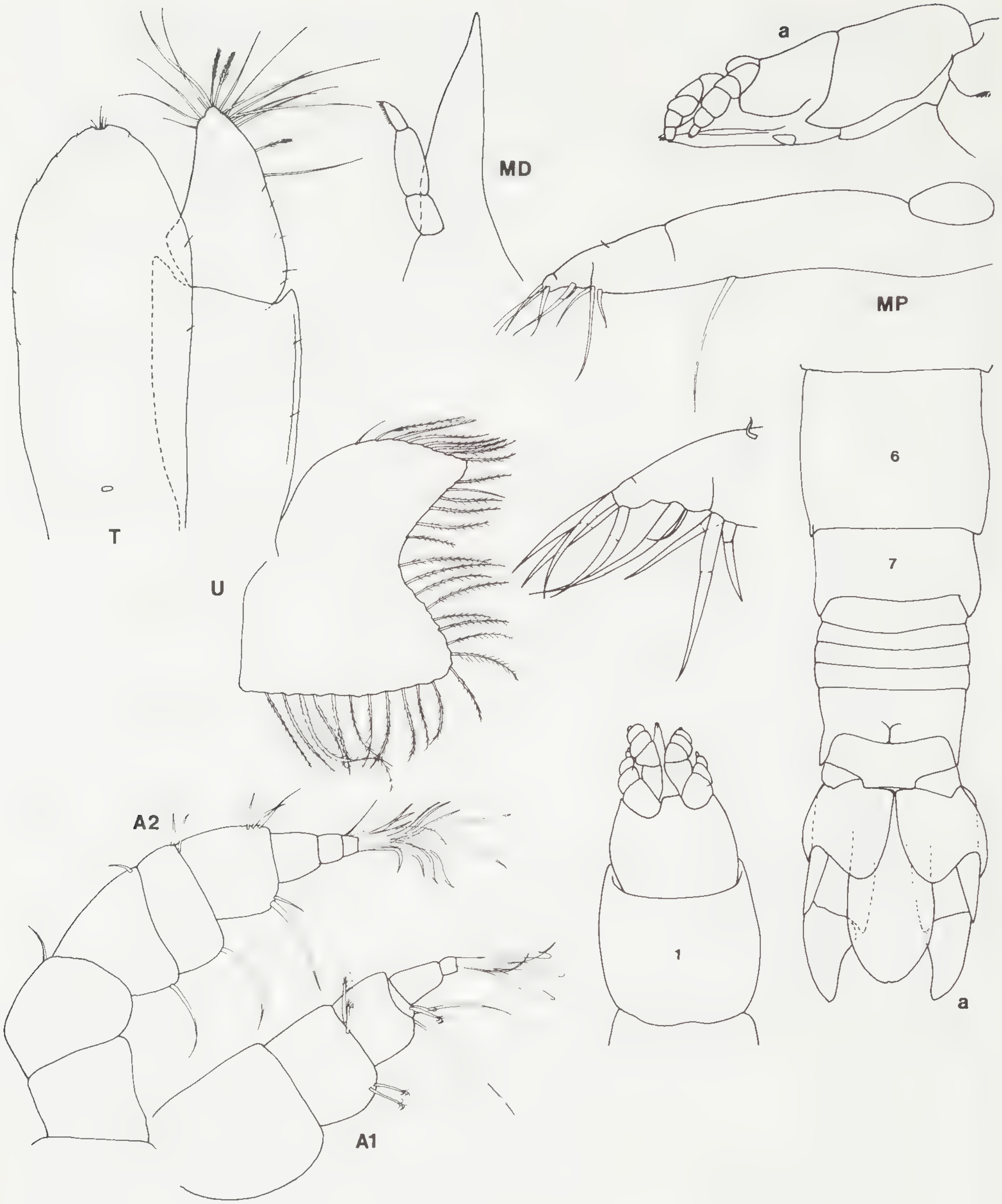

Figure 14—*Leptanthura boweni.* Holotype, juvenile, 6.0 mm (NMV J932, 3); a, juvenile (NMV J934).

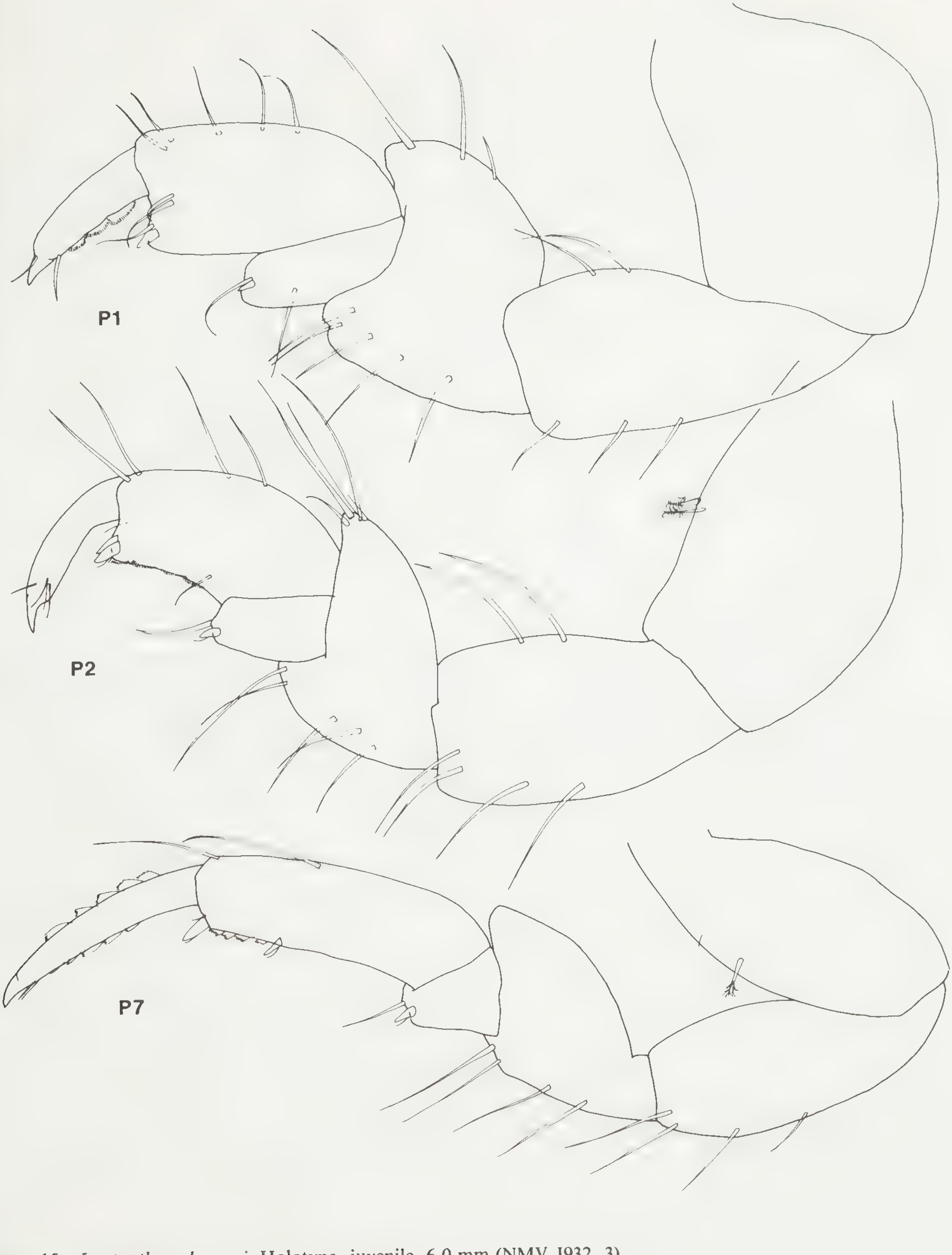

Figure 15—*Leptanthura boweni*. Holotype, juvenile, 6.0 mm (NMV J932, 3).

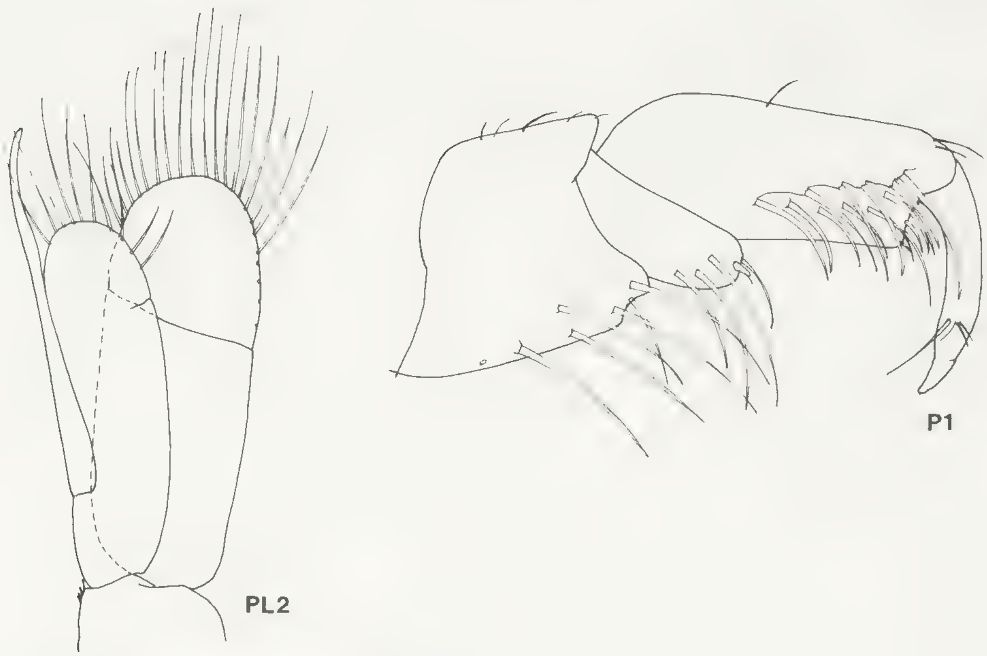

Figure 16—*Leptanthura boweni.* Male (NMV J936, 7).

Leptanthura flindersi new species
Figures 17, 18

Description: Female: Head as wide as long, shorter than pereonite 1; rostrum truncate, little shorter than lateral lobes. Pereonite 7 is two-thirds length of pereonite 6. Pereonite 1 with weak lateral ridges. Pereonites 3-6 with shallow dorsal pits. Pleon little longer than pereonite 7.

Antenna 1 flagellum of 3 articles, as long as last article of peduncle, with 3 setae and 2 or 3 aesthetascs. Antenna 2 sharply tapering, flagellum of 4 articles, only half as long as last article of peduncle, with numerous setae.

Mandibular palp article 2 with 1 seta, article 3 with 2 terminal spines. Maxilliped basis not distinct from head, bearing 2 ventral setae distally; maxillipedal palp of 3 partially separated articles, articles 1 and 2 together with 4 ventral and 1 dorsal setae, and article 3 with 4 terminal setae.

Pereopod 1 stout; article 5 with 2 anterior spines and 1 seta; article 6 swollen, palm well separated from distal corner of article 5, palm oblique and with a proximal thumb, with 7 lateral complex spines and mesial setae; article 7 as long as palm. Pereopods 2, 3 less stout than 1; article 5 with 2 spines; article 6 palm without thumb but with 4-5 lateral spines. Pereopods 4-7 similar; article 5 with 1 anterior spine; article 6 at least half as wide as long, with 2 anterior spines; article 7 shorter than 6.

Uropodal peduncle with blunt distomesial angle; endopod broadly triangular with convex margins, setose, two-thirds length of peduncle; exopod with a shallow distal concavity, longer than wide, setose, ventral part broadly rounded, dorsal part a reduced semicircular lobe. Telson shorter than uropod, dorsally concave, widest near its broadly rounded end; 4 terminal setae and 3 pairs of submarginal setae in distal third.

Pleopod 1 exopod operculiform.

Material examined: 2 juveniles; 3.5-5.3 mm.

Holotype: Juvenile, 5.3 mm, NMV J960 and J961 (slide).

Type locality:
TASMANIA. Schouten Passage, N. of Schouten Island., 12 m, sand and corallines,

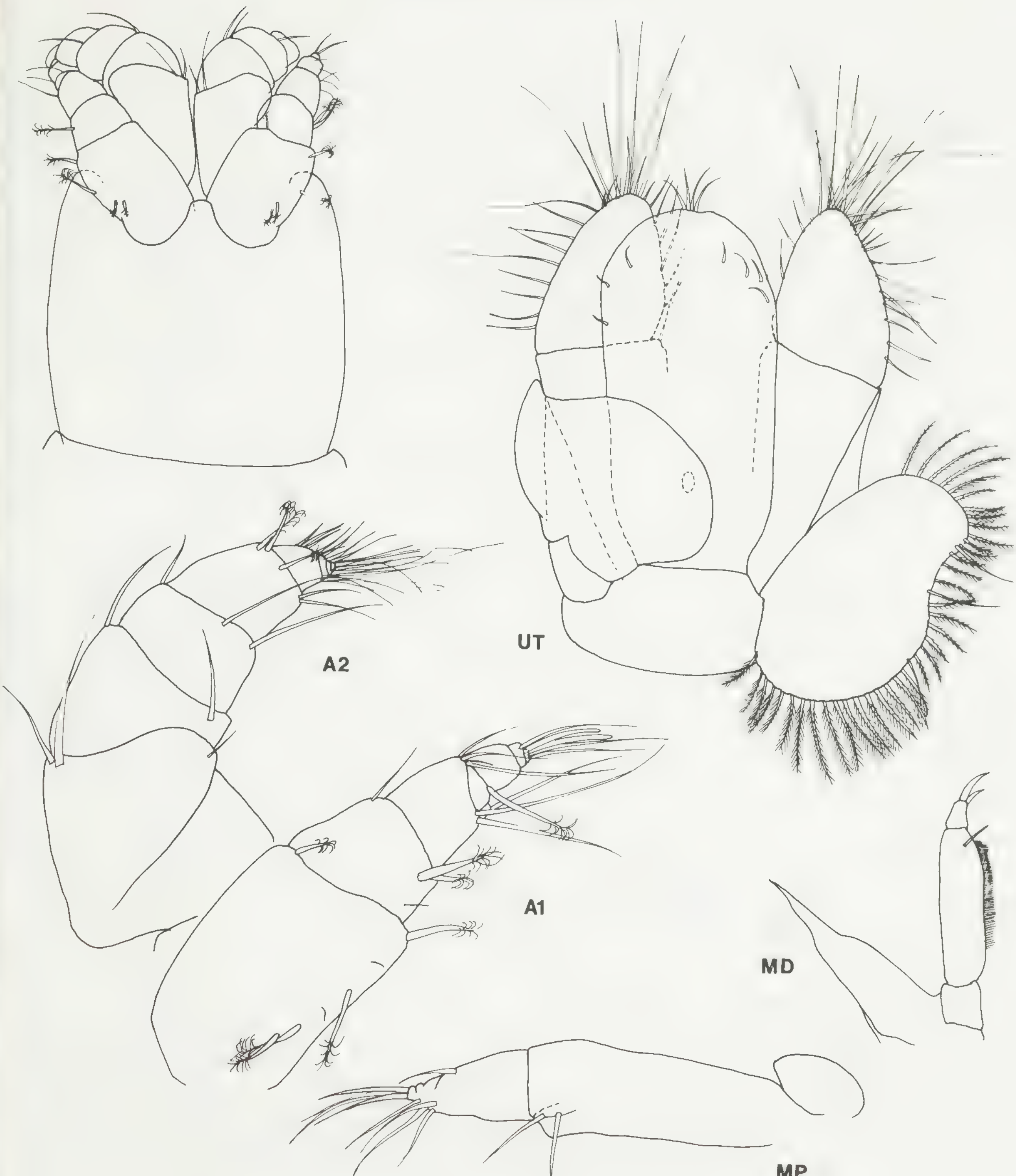

Figure 17—*Leptanthura flindersi*. Holotype, juvenile, 5.3 mm (NMV J960, 1).

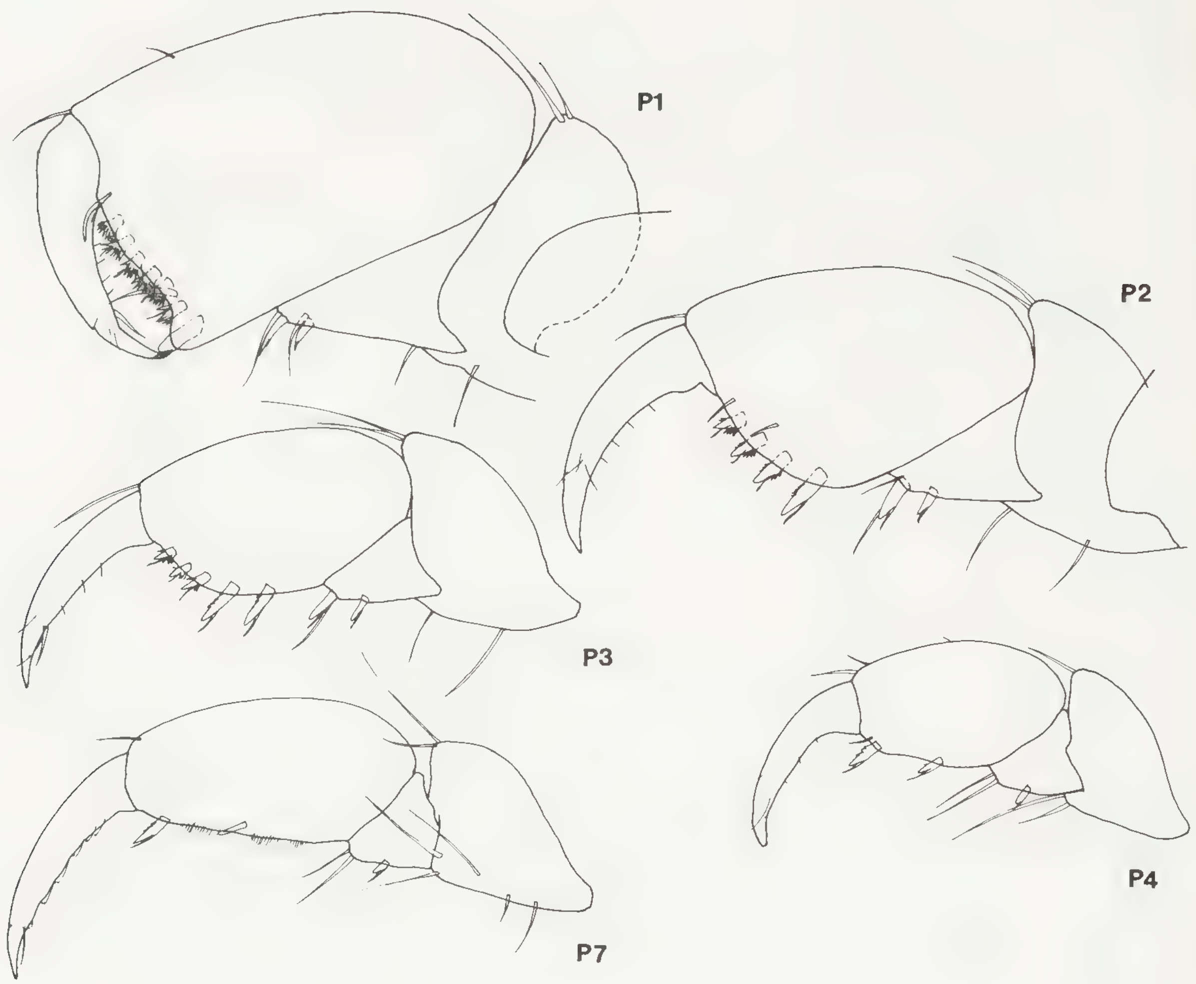

Figure 18 – *Leptanthura flindersi*. Holotype, juvenile, 5.3 mm (NMV J960, 1).

coll: A. J. Dartnall on FRV "Penghana", 8 June 1977, Van Veen Grab.

Paratype:

N.S.W. Long Reef, Sydney, 23.8 m, coll: AMSBS, 27 Apr 1972, AM P24358(1).

Distribution: N.S.W. and Tasmania east coast; 12-24 m.

Remarks: L. flindersi is a small species distinguished from other species in south-eastern Australia by the broad uropodal endopod, the three pairs of submarginal setae on the telson and the oblique palm on pereopod 1.

Leptanthura murrayi new species
Figures 19, 20

Description: Female: Head longer than wide, almost as long as pereonite 1. Pereonites 4-6 with pits and transverse grooves at anterior margin of dorsum.

Antenna 1 flagellum of 3 articles, first the longest and equal to last peduncle article. Antenna 2 flagellum of 2 short articles.

Mandible with an acute incisor, palp article 2 is 3 times length of first, with 1 seta; palp article 3 with 2 barbed spines distally. Maxilliped basis

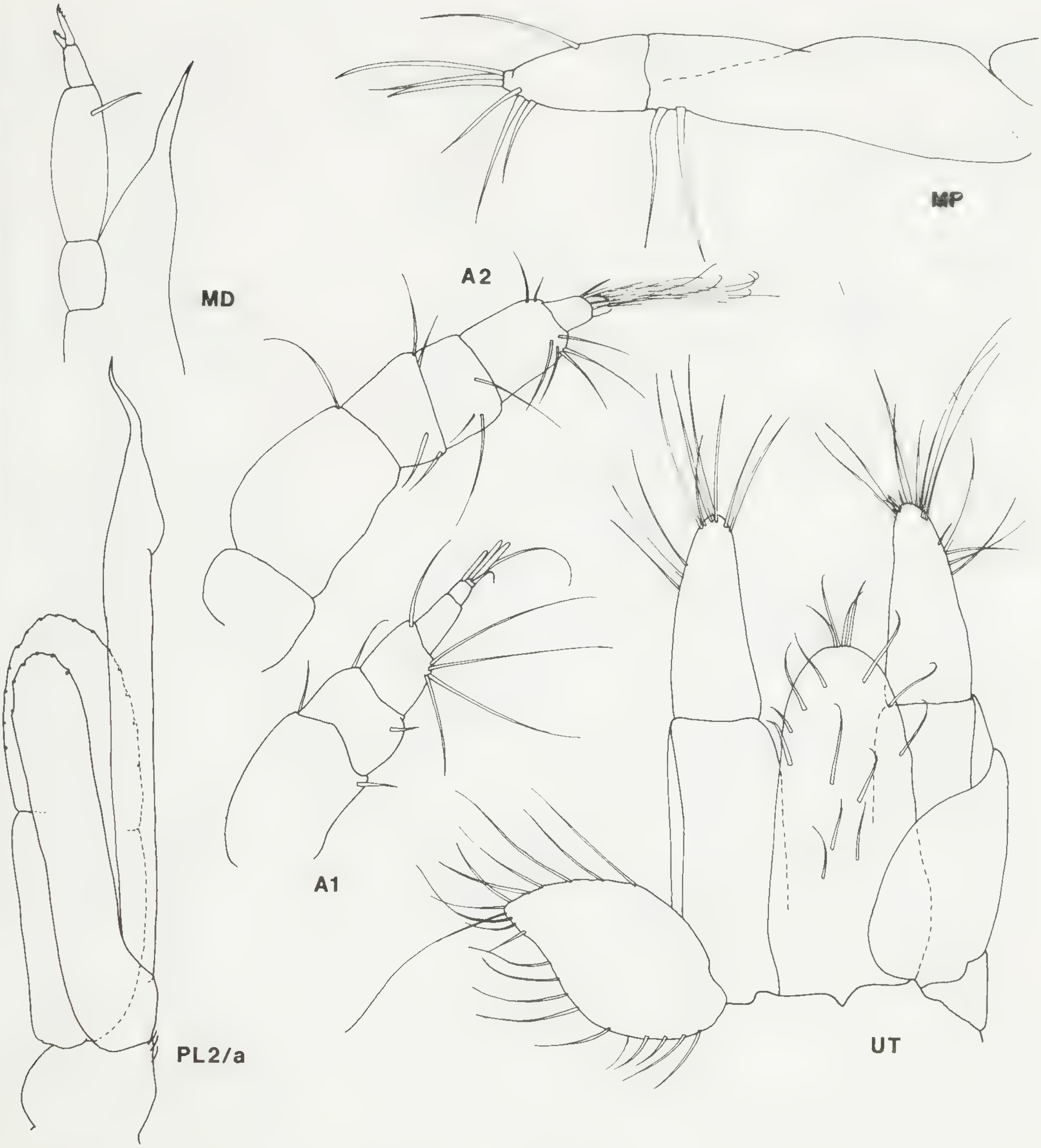

Figure 19—*Leptanthura murrayi*. Holotype, juvenile, 6.6 mm (NMV J862, 3); male (NMV J868).

not distinct from head, bearing 2 ventral setae distally; maxillipedal palp of 2 poorly distinguished articles, the second minute; article 1 with 3-4 ventral and 1 dorsal setae, article 2 with 3-4 setae.

Pereopod 1 stout, palm almost transverse, its short proximal thumb well separated from the distal corner of article 5. Article 5 of pereopod 1 with 2 spines; article 6 elongate, more than twice as long as wide, its palm with 7 lateral

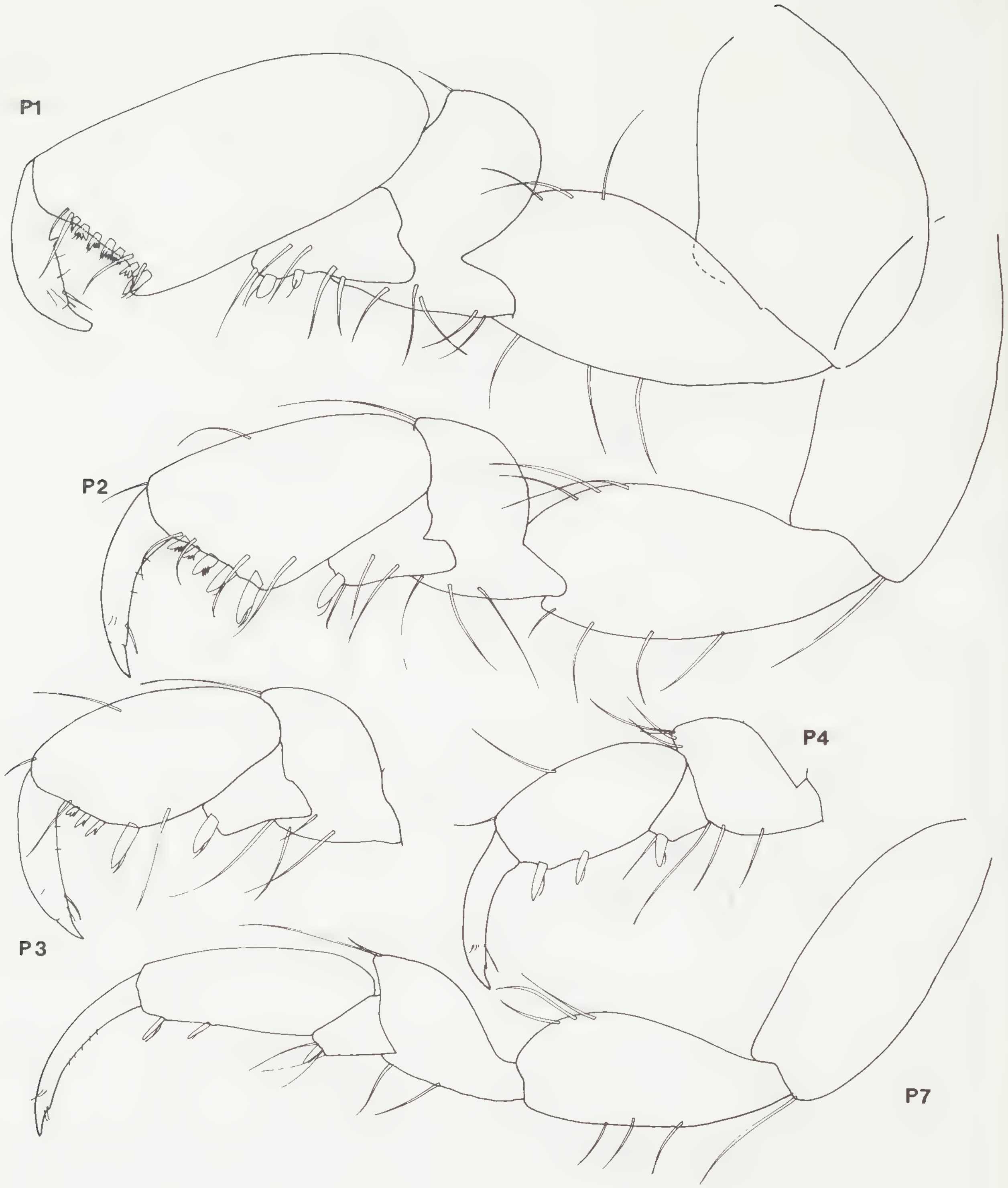

Figure 20—*Leptanthura murrayi*. Holotype, juvenile, 6.6 mm (NMV J862, 3).

complex spines with interspersed setae; article 7 as long as palm. Pereopods 2, 3 less well developed than first, fewer spines on articles 5 and 6, article 6 less inflated than on pereopod 1. Pereopods 4-7 progressively more elongate, article 5 small, triangular and with 1 spine; article 6 with 2 spines; dactyl as long as palm of article 6.

Uropodal endopod triangular, setose, about two-thirds length of peduncle, little more than twice as long as broad; exopod acute distally, setose, more than half as wide as long. Telson shorter than uropod, dorsally convex, gradually tapering to a rounded apex; statocyst opening by a proximal slit; 4 terminal setae and scattered dorsal setae.

Male: Differs from above description in possession of setose 7-articled flagellum on antenna 1 reaching to middle of pereonite 1; elongate pereopods; setose palm on pereopod 1; appendix masculina broad, almost twice as long as endopod of pleopod 2, distally slender, tapering.

Material examined: 2 males, 19 juveniles; 4.6-6.6 mm.

Holotype: Juvenile, 6.6 mm, NMV J862 and J863 (slide).

Type locality:
VICTORIA. Crib Point, Western Port, 38°20.94′S, 145°14.08′E, 16 m, muddy sand, coll: Marine Pollution Studies Group 30 Mar 1965 (CPBS stn 51N).

Paratypes:
VICTORIA. Crib Point, Western Port, 12-19 m: CPBS stations: C4(1), 32N(1), 51N(9), 600(2), 61N(1) NMV J864-867, AM P30724.

Western Port, 24 m: WPES station 1746(7) NMV J868.

Distribution: Victoria (Western Port); sandy sediments; 12-24 m.

Remarks: Leptanthura murrayi, at 6.6 mm, is the smallest species of the genus so far known from Australia. It is distinguished from the slightly longer *L. nunana* Poore by shorter and broader uropodal rami, by the arrangement of setae on the maxilliped and the form of the pereopods, particularly the first.

The unusually broad and long appendix masculina of this species sets it apart from all other species in the genus; it is a form unusual in the family.

Ulakanthura Poore

Ulakanthura Poore, 1978: 147-150.—Poore, 1980: 64.

Remarks: Diagnoses for this genus have been provided recently by Poore. It is characterised by being blind, having a mandibular palp of a single article and having posterior lobes on article 4 of pereopods 4-7.

Ulakanthura marlee new species
Figures 21, 22

Ulakanthura colac Poore, 1978: 152-154 (part from Victoria and N.S.W.).—Dorsey & Synnot, 1980: 159.
not *Ulakanthura colac* Poore, 1978: 152-154, figs 12, 13 (part from Queensland).

Description: Female: Head longer than wide, as long as pereonite 1; rostrum acutely triangular; eyes absent. Pereon with obsolete dorsolateral grooves, dorsal pits and paired rows of setae on dorsum of pereonites 4-6. Pleon little longer than pereonite 6, pleonites distinct.

Antenna 1 flagellum of 3-4 articles, little longer than last article of peduncle. Antenna 2 flagellum of 4 setose articles.

Mandible with an acute incisor, palp a single small article. Maxilliped basis not distinct from head, with 1 distal ventral seta, 2 distal dorsal setae and 8-12 setae laterally; maxillipedal palp of 3 poorly defined articles, first with 1 dorsal seta, second with 4 ventral and third with 4 distal setae.

Pereopod 1 stout, palm oblique and with a small thumb proximally. Article 5 of pereopod 1 with 3-4 spines; article 6 with 10 spines along the cutting edge. Pereopod 2 articles 6 broader than that of pereopod 1, palm oblique. Article 5 of pereopods 2, 3 with 2-3 spines; palm of article 6 with a proximal thumb and row of 11 spines laterally. Pereopods 4-7 dissimilar to pereopods 1-3, subequal. Article 4 of pereopods 4-7 setose, lobed posteriorly, the lobe reaching to the distal end of article 5 on pereopod 4 and just short of this point on pereopod 7; article 5 with 4 spines; article 6

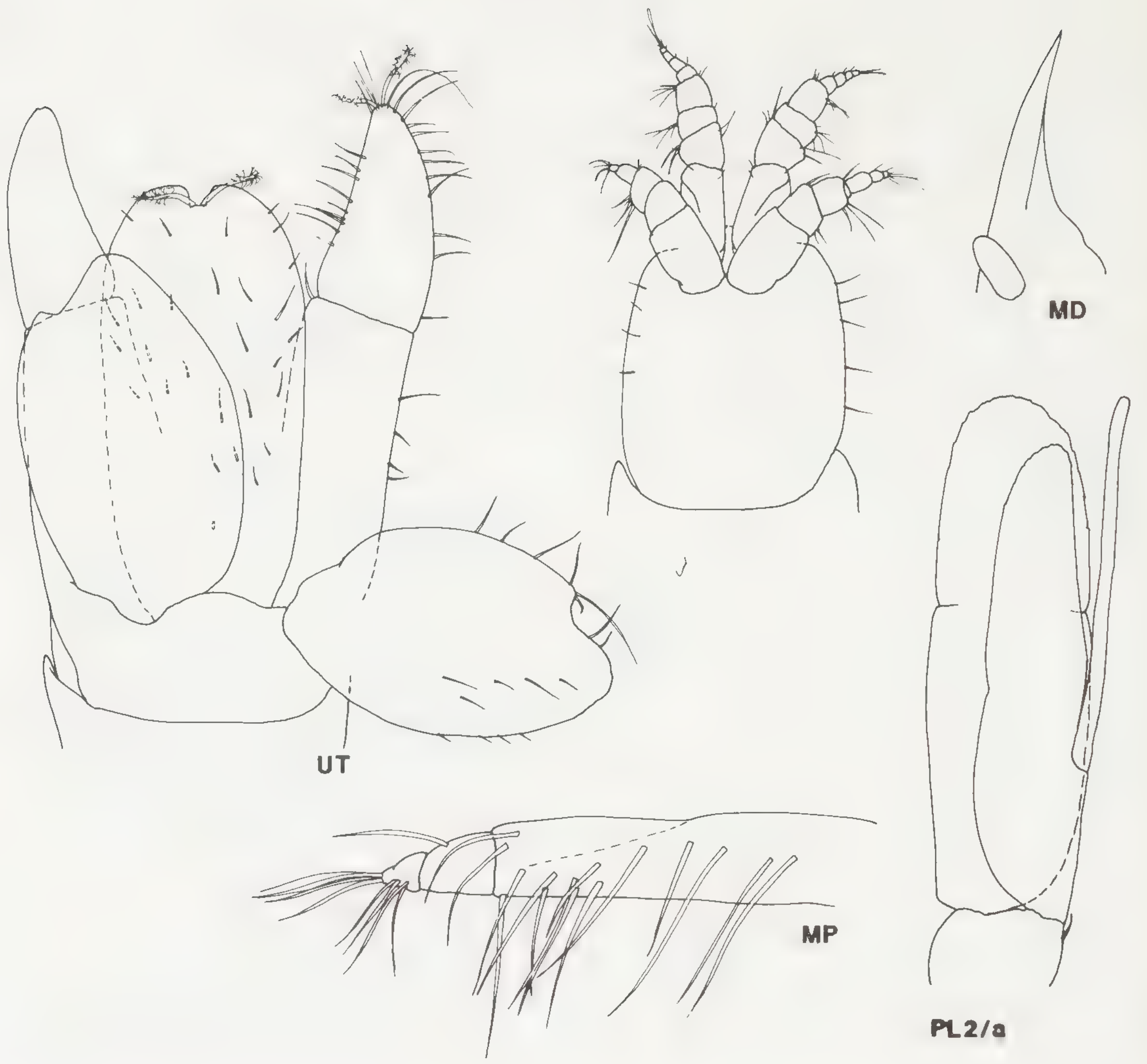

Figure 21 – *Ulakanthura marlee*. Holotype, juvenile, 11 mm (NMV J490, 1); male (NMV J494).

with 4-5 spines; article 7 barely tapering, with 1 long seta and 1 short terminal spine.

Uropodal endopod setose, triangular, not quite twice as long as wide; two-thirds as long as peduncle; exopod broad and with a shallow subterminal cleft situated such that dorsal apex is longer than ventral apex of exopod. Telson reaching halfway along endopod, dorsally concave, slightly splayed, tapering to a broadly rounded end divided by a square notch; statocyst opening by a small dorsal pore; brush-setae in the terminal notch and scattered short setae dorsally.

Colour in alcohol cream.

Male: differs from above description in setose palm of pereopod 1; flagellum of antenna 1 with 14-15 articles bearing numerous aesthetascs reaching as far back as middle of pereonite 2. Appendix masculina a simple rod reaching to the end of the exopod of pleopod 2.

Material examined: 4 males, 1 female, 45 juveniles; 4.0-11.0 mm.

Holotype: Juvenile, 11.0 mm, NMV J490 and J491 (slide).

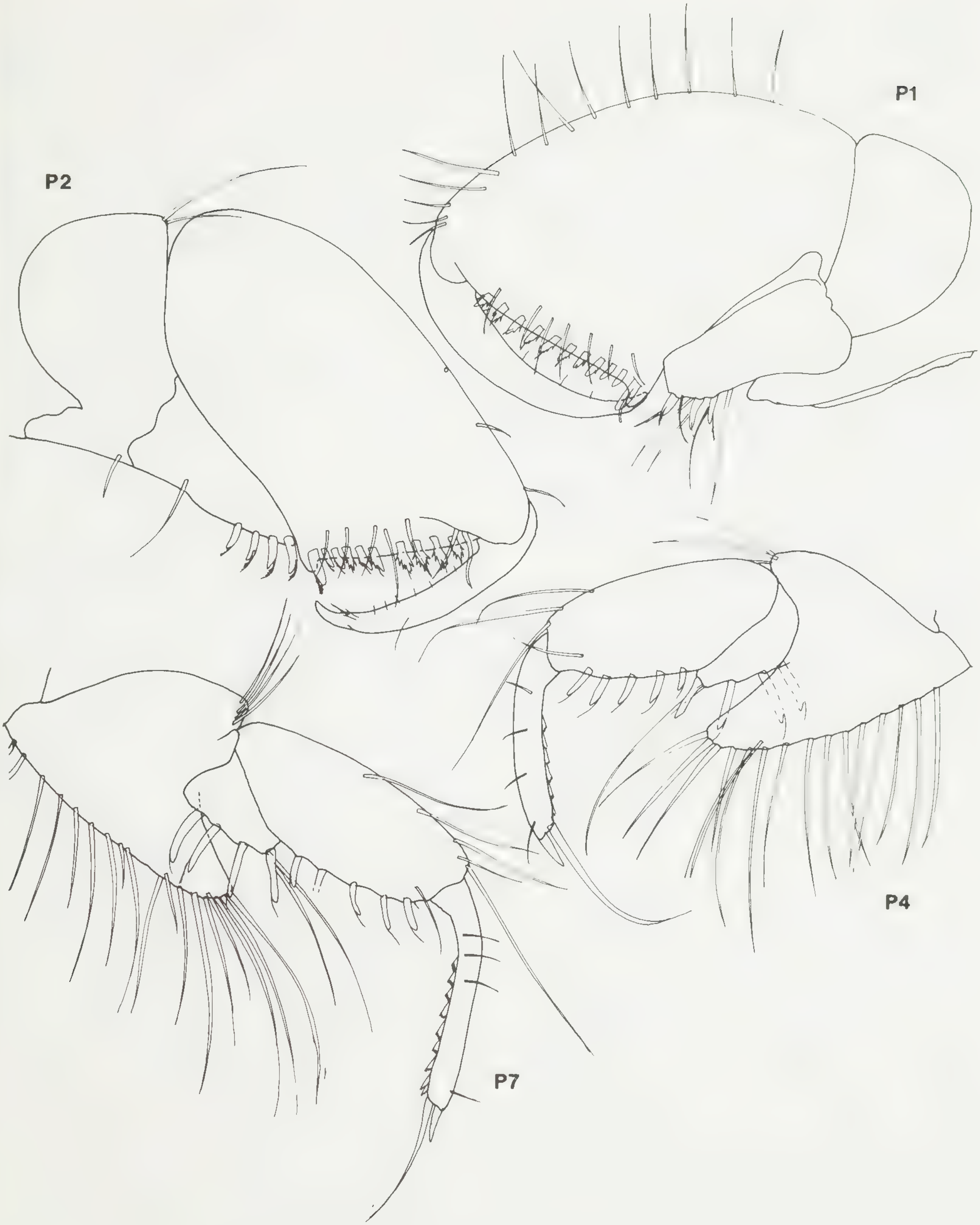

Figure 22 — *Ulakanthura marlee*. Holotype, juvenile, 11 mm (NMV J490, 1).

Type locality:
VICTORIA. Port Phillip Bay, 38°11.7′S., 144°44.7′E., 10 m, sand, coll: Marine Pollution Studies Group, 16 Feb 1971 (PPBES station 960).

Paratypes:
VICTORIA. Port Phillip Bay, 5-10 m: PPBES stations: 960(1,2,16), 967(1) NMV J492-495.

Black Rock, Breamlea, 9-20 m: NMV J956(1), NMV J957(2), NMV J958(2), NMV J959(1).

Other material: N.S.W. Hawkesbury River, off Juno Head, 10 m, sandy mud, coll: A. Jones and C. Short, 5 May 1977-21 Feb 1978, (AMHRS stations 1.3 and 1.4) AM P28603(1), P28604(4), P29743(3), P29744(2), P29745(1), P29746(2), P29747(1), P29748(1), P29749(1), P29751(1). P29752(1), P29753(1), P29755(4).

Distribution: N.S.W. and Victoria; 5-20 m; well sorted sandy sediments.

Remarks: This species was previously confused with *Ulakanthura colac* from Moreton Bay, Queensland. The differences are small but consistent. The end of the telson is more acute than the rounded-truncate form of *U. colac;* the uropodal endopod is shorter, the exopod is broader, its two lobes not the same length as in *U. colac*; the posterior lobe of pereopod 7 is longer; and the palm of pereopod 1 is more oblique than in *U. colac*.

Acknowledgements

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DISTRIBUTION AND STATUS OF COASTAL COLONIES OF SEABIRDS IN VICTORIA

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Abstract

Most of the known seabird colonies around the Victorian coast were surveyed between October and December 1978; others were examined in 1979 and early 1980. Data collected included colony area, nest-site density, associated vegetation and soil depth. There were some 1.45 million burrows of Short-tailed Shearwaters *Puffinus tenuirostris* in Victorian colonies and about 20 000 nest sites of Little Penguins *Eudyptula minor*, the two most abundant species encountered. Earlier estimates of colony numbers or size are reviewed together with survey estimates and the individual species' status is considered and compared with other Australian data. The threats to breeding areas and to the species in Victoria are considered.

Most Victorian seabird colonies are currently secure although some breeding sites are being reduced by land development. Man's increasing use of the coast, and the associated increased predation by dogs, may be locally severe but is of little importance to populations generally. Oil spills and other pollutants present potential threats and possible competition between seabirds and the local fishing industry requires investigation.

Introduction

In a changing environment conflict between the requirements of man and those of wildlife is inevitable. As well as killing or hunting wildlife of all types for food or sport, man affects wildlife indirectly by removing or modifying habitats and by introducing detrimental substances. Consequently populations of animal groups such as seabirds may alter dramatically. In Australia there have been a few attempts to assess the sizes of breeding colonies of seabirds comparable with those conducted in Britain and Ireland (e.g. Cramp, Bourne and Saunders, 1974) or Canada (e.g. Nettleship, 1977) but recently some accounts of island seabird colonies have been published (in the *Australian Bird Bander* and its successor the *Corella*). However, such details are generally lacking for Victorian colonies.

The present study was designed to produce data against which subsequent changes may be evaluated, and from which management procedures may be formulated to retain 'desirable' species at appropriate levels.

Methods

Between October and December 1978, attempts were made to visit the larger coastal islands of Victoria (Figure 1). Some islands were also revisited in 1979; Lady Julia Percy (January); Citadel (February); South Channel (June); Rabbit (December). Wattle Island was surveyed in December 1979 and Dannevig and Norman Islands were visited in January 1980. A few of the smaller islands for which recent details were available were not investigated, nor were the more inaccessible stacks in the Bay of Islands Coastal Park and the Port Campbell National Park. Mainland colonies of some species were also visited, but the data collected are incomplete. Data from published and unpublished sources have been incorporated below. In this survey we consider the following species in detail:

Little Penguin	*Eudyptula minor*
Fairy Prion	*Pachyptila turtur*
Short-tailed Shearwater	*Puffinus tenuirostris*
White-faced Storm Petrel	*Pelagodroma marina*
Common Diving-Petrel	*Pelecanoides urinatrix*
Australasian Gannet	*Morus serrator*
Black-faced Shag	*Leucocarbo fuscescens*
Silver Gull	*Larus novaehollandiae*
Pacific Gull	*Larus pacificus*
Kelp Gull	*Larus dominicanus*
Caspian Tern	*Hydroprogne caspia*
Crested Tern	*Sterna bergii*

Techniques for the estimation of seabird populations, and the accuracy of such estimates, depend largely on the species involved. Methods used tend to be group-specific and vary from direct counts (of nests, or pairs, or eggs, etc.) to sampling segments of colonies and extrapolation of areas occupied. For bur-

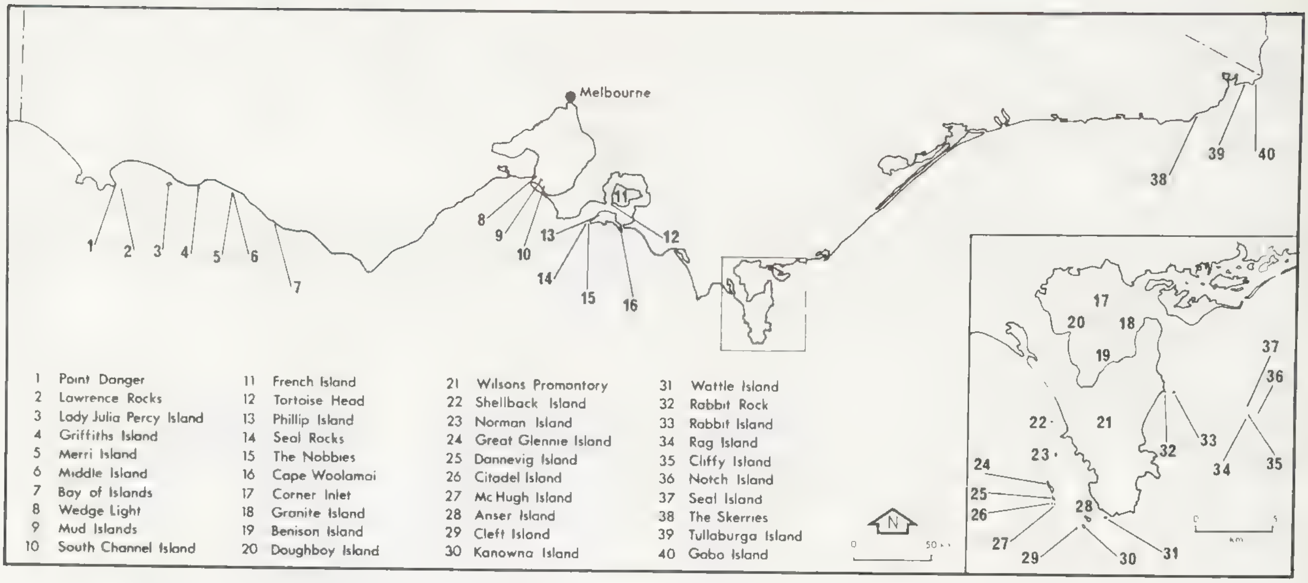

Figure 1. Main localities mentioned in text.

rowing species particular problems exist with temporal variation in occupancy, burrow density (which can be materially affected by substrate) and burrow or colony distribution. Additionally, the identification and numerical determination of nest sites themselves may be difficult or impossible in certain terrain (for further details see Nettleship, 1976). The techniques used in this survey are discussed below: time and weather constraints added to other practical problems. Survey information is summarised in Appendix 1, and further, more descriptive, details may be found in the series of articles on individual islands published mainly in *Corella* (and listed in the references) or in Harris (1979), as may earlier information on the islands.

Existing or potential threats to colonies were recorded. Whilst human disturbance may affect all seabird colonies only observed instances are listed below.

SHORT-TAILED SHEARWATER

The boundaries of colonies usually coincided with changes in vegetation and were marked on local maps or aerial photographs (black and white or colour) of largest available scale. Larger colonies were subdivided, where practicable, according to vegetation or physical features, and areas determined from the scale drawings. However, areas of small colonies were determined by ground measurement. Because no allowance was made for irregular topography the areas of many colonies were slightly under-estimated.

In small colonies, the numbers of burrows showing signs of current usage were counted directly. Elsewhere burrow density was determined by counting burrows in circular quadrats of 20 m². In the larger colonies (e.g. Cape Woolamai), and in those with prominent features (e.g. Griffiths Island, Corner Inlet islands), the quadrats were selected by means of a numbered grid, superimposed on a map or photograph of the colony, and tables of random numbers. In some colonies the quadrats sampled were at irregular intervals of 5-10 m, along a zig-zag path from one side of the colony to the other. The position of the quadrat was determined by throwing a metal rod about 5 m ahead. Quadrats which covered bare rock were always included. Total numbers of burrows in colonies were determined from the product of colony area and mean burrow density; 95% confidence limits are ± 2 SE of the mean density. Most nest sites had only one entrance but some had several; how this affects estimates of breeding pairs is not known. No allowance is made for possible error in delineation of colony boundaries.

For most Short-tailed Shearwater colonies samples of burrow density were sufficient to provide reasonably restricted 95% confidence limits (given as ranges below). The accuracy of such estimates is unlikely to be greatly increased since some quadrats always contain no burrows. However, the largest source of error was in determining the areas of colonies: in low-density colonies with scattered, outlying burrows boundaries were particularly difficult to delineate.

On 1 November 1978, before laying, 56 burrows on Phillip Island were individually marked; on 22 December 46 (82%) held eggs. A further 150 burrows were examined on Great Glennie Island (7-11 December 1978); these held 98 eggs (e.g. 65%). Burrows were also examined on Wattle Island (12 December 1979; 50, 34 occupied).

LITTLE PENGUIN

The above procedure was generally adopted in penguin colonies, but only burrows with adults, young, eggs or accumulations of droppings were counted. Because burrow densities in colonies among rocks, or in thick vegetation (where there tended to be few), were difficult to estimate, the numbers of burrows in the more accessible areas of such colonies were determined and extrapolated to provide estimates of burrow densities. However, on some islands even this proved impossible and only the order of magnitude of burrow densities is proposed below.

Conversion of number of burrows to number of breeding pairs is unreliable in this species, since breeding seasons may be extended and some pairs may breed more than once in a season (Reilly and Balmford, 1975).

WHITE-FACED STORM PETREL

On Tullaberga and South Channel Islands the extent of the breeding colony was marked directly onto an aerial photograph and a map respectively; on the Mud Islands the area of the colony was measured with marked ropes. In all instances burrow densities were measured in circular quadrats of 1 m radius (3.14 m^2).

OTHER SPECIES

On most islands Fairy Prion and Common Diving-Petrel burrows were difficult to find and impossible to census, hence the population sizes of each colony are only general impressions. Nests of Australasian Gannets were counted, as were those of gulls and terns where practicable. When gull colonies were inaccessible the number of pairs holding territories was estimated and added to counts of nests. Replicate counts were not made, but inter-observer differences were minimised since all counts in 1978 were made by the senior author.

Results

1. ISLAND/COLONY DETAILS

Survey dates, methods and results (including population estimates) are summarised in Appendix 1 for the individual islands examined and totals for Little Penguins and Short-tailed Shearwaters given in Table 1. Details for other colonies (not surveyed) are as follows:

Skull (Cleft) Island

Black-faced Shags recently bred on the island (Lane, 1979b) and burrowing species may nest in the apparently sparse vegetation.

Killarney Reef

Some 500 pairs of Silver Gulls and about 200 pairs of Crested Terns have been recorded as nesting (Bowker, 1980a).

Bay of Islands

Hundreds of Short-tailed Shearwaters were seen on a stack off Boat Bay in about 1960 (W. Matheison, *pers. comm.*), and Black-faced Shags bred on one of the islands in the Bay (Reid, Shaw and Wheeler, 1971).

Twelve Apostles

Black-faced Shags were seen sitting on nests in November 1978.

Muttonbird Island

This is a dense but inaccessible Short-tailed Shearwater colony of many thousands of birds. There is a small shearwater colony on the mainland opposite, and the species probably breeds (but in small numbers, since there is little soil) on some of the other stacks in this area.

TABLE 1

Estimates of numbers of burrows of Little Penguins and Short-tailed Shearwaters at colonies in Victoria in 1978.

	Penguin	Shearwater Mean	Range
Lady Julia Percy Island	2000	15300	13100-17400
Lawrence Rocks	109*	0	–
Griffiths Island and Port Fairy mainland	0	52100	45500-58600
Middle Island	10*	0	–
Merri Island	199*	0	–
Other colonies west of Port Phillip Bay	500	10000 +	–
Mud Islands	< 5	0	–
South Channel Island	30-40	0	–
Phillip Island	6000	542300	439300-645300
French Island	?	3100	1800-4400
Granite Island	0	2100	1600-2400
Benison Island	0	7200	5900-8400
Doughboy Island	0	2000	1600-2300
Great Glennie Island	500	400300	334500-456300
McHugh Island	1000	6200	4500-7900
Citadel Island	45*	111*	–
Dannevig Island	hundreds	44600	37800-51300
Norman Island	400-500	145000	131350-158500
Anser Island	hundreds	251700	216200-287100
Kanowna Island	small numbers	52000	38300-65500
Shellback Island	hundreds	109500	87400-131600
Wattle Island	1000	83450	74650-92400
Rabbit Island	500	131000	115200-146600
Rabbit Rocks	100	3800	3200-4300
Seal Island	hundreds	54000	46800-60400
Notch Island	500	6000	4600-7300
Cliffy Island	0	6300	–
Rag Island	hundreds	18200	16100-20300
Skerries Rocks	< 10		–
Tullaberga Island	400-500		–
Gabo Island	5000-10000	7350	5000-9400
Victoria Total	c. 20,000	c. 1.45 million	

* Number counted

The Skerries Rocks

Barton (1978) recorded breeding Little Penguins (7 nesting pairs), Silver Gulls (14) and Crested Terns (28 nests and other runners).

OTHER COLONIES IN SOUTH-WEST VICTORIA

Small numbers of Short-tailed Shearwaters may try to breed regularly at Point Danger but the only definite breeding records are those of Learmonth (1965). Streeter (1979) found 272 freshly dead shearwaters, mostly killed by foxes, between 11 December 1978 and 13 January 1979. Shearwaters also breed at Crofts Bay (G. E. Cerini, *pers. comm.*) and possibly at Flaxman Hill (Dorward, 1976). Little Penguins breed in Port Campbell National Park (130 young banded there in 1979, P. N. Reilly *in litt.* to Fisheries and Wildlife Division), Gibson's Steps (about 300 burrows in two colonies, P. C. Kelly, *pers. comm.*), Three Mile Beach (L. McDonald, *pers. comm.*), Antares (D. McDowall, *pers. comm.*), Flaxman Hill (Dorward, 1976), and Portland Harbour Beach (a colony now much diminished due to changes in the nesting area, G. E. Cerini, *pers. comm.*). Many of these mainland breeding sites are damaged by vandals, and birds are killed by dogs and foxes. No attempt was made to census the mainland colonies of terns or gulls but

known breeding sites are listed in the species accounts.

During this survey we did not find Short-tailed Shearwaters or Black-faced Shags breeding on Lawrence Rocks though Mattingley (1908) recorded them in the past. Little Penguins occasionally breed on the Mud Islands (Kerry and Hall, *in press*), and French Island has been reported as a breeding site (Serventy *et al.*, 1971); we found no breeding birds, and nor were nest sites of penguins, Fairy Prions or Common Diving-Petrels found on Cliffy Island (cf. Campbell, 1900; Gillham, 1962). Common Diving-Petrels were not found on McHugh Island, where Gillham (1962) recorded several hundred burrows, or on Kanowna Island where Lane (1979b) found several burrows, probably of this species. No breeding Silver Gulls or Crested Terns were present on Rabbit Rocks when visited (cf. Gillham, 1961).

2. NUMBERS OF SEABIRDS IN VICTORIA

The following account includes a discussion of the estimated population sizes of some species of seabirds breeding in Victoria. An attempt is made to compare our data with earlier details, though those available give no indication either of accuracy or even of methods used. Victorian data are then considered within an Australian context.

Little Penguin

The total number of burrows in Victoria appears to be in the order of 20 000, of which about 30 per cent are on Phillip Island*, 30 per cent on Gabo Island, 30 per cent on islands off Wilsons Promontory, and 10 per cent elsewhere (mainly on Lady Julia Percy Island, see Table 1). Whilst a few mainland colonies (mainly in the Port Campbell area) may have been overlooked, such small colonies are insignificant compared with possible errors in estimates of birds in the larger colonies or the generalised estimates for some of the Wilsons Promontory islands.

Variability in estimates (Table 2) relate in part to methods used. However, on Gabo Island there seems to have been a reduction in population size (cf. Gillham, 1961), and large variation in numbers breeding may also occur (Reilly and Kerte, 1978). On Phillip Island too, there has been a contraction in numbers of colonies and apparently numbers of birds (cf. Nicholls, 1918 with details in Harris and Bode, 1981).

The species commonly breeds around the southern Australian coast, and Serventy *et al.* (1971) listed some 116 known colonies of which 10 were in Victoria. We found them at 23 sites, and others have reported breeding at a further nine sites. Lane (1979a) summarised information from islands off New South Wales, and estimated some 16 800 breeding pairs, an estimate similar to that for Victoria.

Fairy Prion

The species was breeding on eight islands, and it may have nested on five others. Though an earlier breeding site was not confirmed (Cliffy), the increase in the numbers of Victorian sites is the result of a more comprehensive survey rather than increased range. Numbers were generally small, except on Lady Julia Percy Island where there were probably thousands of birds.

The species breeds on several islands around Tasmania but, again, numbers are generally small except for 'thousands' on Green Island and a 'very large population' on Albatross Island (Green and Mollison, 1961; MacDonald and Green, 1963; and references in Green, 1977). The Bass Strait region is the Australian stronghold of the species, and Victoria has a large proportion of the Australian population.

Short-tailed Shearwater

The number of burrows in Victoria (1978-1980) was estimated as about 1.45 million (see Table 1), many (some 30 per cent of total burrows) were on Phillip Island, and the Seal Group and islands off Wilsons Promontory held a further 63 per cent.

Earlier estimates (Table 2) for some colonies show considerable variation. The fortunes of colonies on Phillip Island are detailed elsewhere; whilst there has been a gradual increase in numbers of colonies it was concluded that the total population had not changed materially in recent times (Harris and Bode, 1981). Some previous estimates for Lady Julia Percy Island appear excessive (Norman *et al.*, 1980),

TABLE 2

Comparison of some earlier estimates of Little Penguin and Short-tailed Shearwater numbers with results obtained during this survey.

	Little Penguin	Short-tailed Shearwater
Lady Julia Percy Island	5,000-10,000 pairs (McKean, 1962) 1,260 pairs (Seal Bay and Dinghy Cove, Reilly, 1977b) 2,000 burrows (Norman *et al.*, 1980)	2 large colonies (Wood Jones and Tubb, 1937) 90,000 burrows (Wheeler, 1965) 50,000 burrows (Reid, Shaw and Wheeler, 1971) 15,300 burrows (Norman *et al.*, 1980)
Phillip Island	20,000 birds (Nicholls, 1918) 50,000-100,000 (Reilly in Kay, 1978) c. 6000 burrows (Harris and Bode, 1981) 26,500 pairs (Cullen and Reilly, 1981)	colony area 251 ha (Sutton, 1933) colony area 250 ha (1939, Seddon, 1975) colony area 129 ha, 542,300 burrows (Harris and Bode, 1981)
Gabo Island	many thousands (Gillham, 1961) some 10,000 (Reid, Shaw and Wheeler, 1971) 20,000-50,000 breeding pairs (Reilly, 1977a) 5,000-9,400 burrows (this survey)	100 pairs (1959; Gillham, 1962) 1,000 pairs (Reid, Shaw and Wheeler, 1971) 20,000-50,000 pairs (Reilly, 1977 a,b) 6,000 burrows (this survey)

but the population on Gabo Island has increased from 100 pairs in 1959 (Gillham, 1962). Other populations have also expanded: Griffiths Island (30 000 birds in 1971, Reid, Shaw and Wheeler, 1971; 43 400 burrows in 1978), French Island (colony founded in the early 1960s, 3 100 burrows in 1978), Citadel Island (none in 1959, Gillham, 1961; 111 in 1978), Cliffy Island (less than 100 pairs in 1959, Gillham, 1961; 6 000 burrows in 1978) and Rabbit Island (where there were 44 600 burrows in an area with few in 1965, Norman, 1967).

Victoria holds about 11 per cent of the colonies listed by Serventy *et al.* (1971), though the species increased in numbers and range during 1920-71 (Serventy *et al.*, 1971), and possibly since. The Tasmanian colonies are large and Naarding (1980) reported 133 colonies containing almost 11.5 million breeding birds. Serventy *et al.* (1971) gave Cat Island (c. 250 000 occupied burrows), Furneaux Group, as an example of a large and dense colony; several Victorian colonies are larger than this. In New South Wales, there are an estimated 25 700 breeding pairs, and the species may have increased both in range and numbers since its discovery in 1958 (see Lane, 1979a for details).

White-faced Storm Petrel

About 32 600 burrows were found on Tullaberga Island, Mud and Fort Islands; details of each colony are provided in Harris (1979). A dead bird was found on Kanowna, but if the species does breed there, the population is small. The species is widespread throughout Australia; Serventy *et al.* (1971) listed some 71 breeding colonies, and Lane (1979a) gave an estimate of 10 700 breeding pairs for ten sites in New South Wales.

No earlier details are available for Tullaberga Island but the Mud Islands colony has frequently been examined (for details see Harris, 1979; Kerry and Hall, *in press*). There seems little doubt that the once-extensive colony (10-11 acres in 1907, Mattingley, 1907) has declined: recent estimates have varied between 3 000 and 6 000 burrows (e.g. Wheeler, 1964a; Gayner, 1978).

The species probably colonized South Channel Island some time after 1919, and the colony was well established by 1932 (Gillham and Thomson, 1961). In 1947 the population was estimated at 2 000 birds, in 1964 2 000 burrows (Wheeler, 1964b) and burrows were estimated at 6 800 in 1978, but there is now little unused soil for additional burrows.

Common Diving-Petrel

During this survey the species was found breeding on five islands; it bred on McHugh and Cliffy Islands previously, and may breed on a further six islands (where dead birds were found). The total population was probably

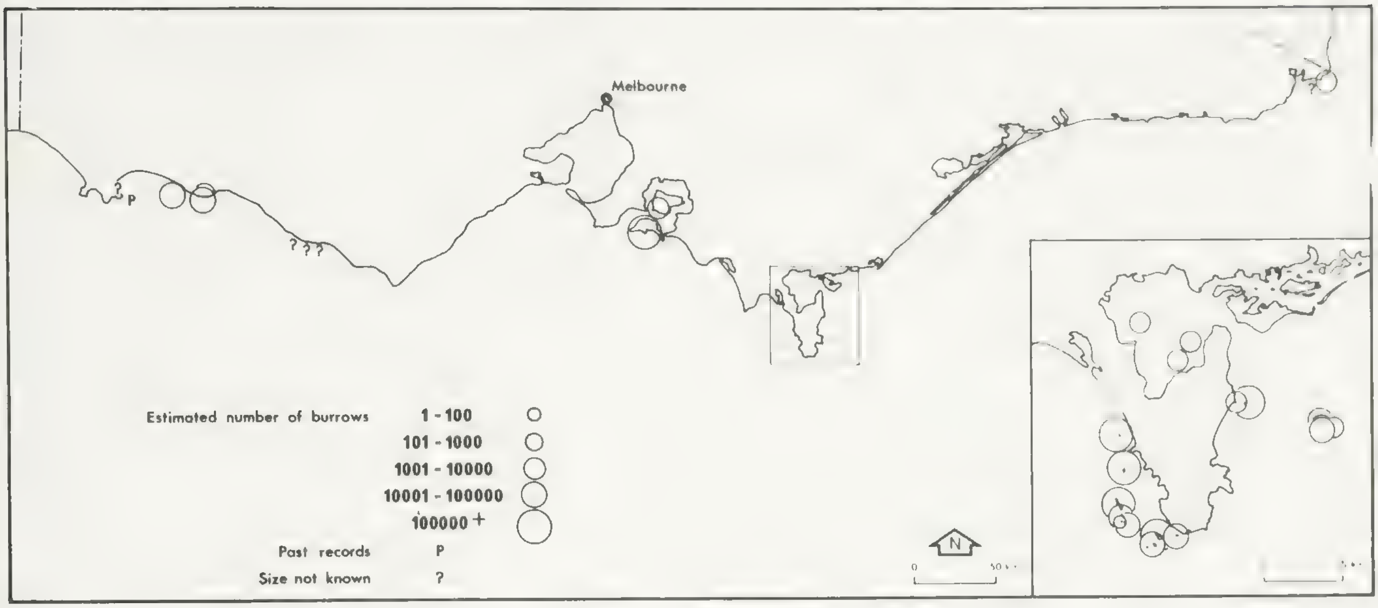

Figure 2. Orders of magnitude for burrow totals estimated in Short-tailed Shearwater colonies, Victoria, 1978-1980.

below a few thousand pairs. The only other recorded Australian colonies are 20 pairs on Councillor Island (Milledge, 1972), and large numbers on Craggy Island (Whinray, 1975), all in Tasmania. Victoria may have, therefore, more than half the Australian colonies but the extension of range reported here must only represent more intensive examination of islands.

Australasian Gannet

The colony on Wedge Platform is of recent origin, six pairs were recorded in 1972 (Nelson, 1978) and 28 nests were found in 1978, but expansion is restricted by available space. In contrast, the colony at the Lawrence Rocks has expanded from 200 nests in 1900 and 1933 (Nelson, 1978), to 605 pairs in 1960-1961 (McKean, 1966) and 1 456 occupied nests in 1978.

The other Australian colonies occur around Tasmania, on Cat Island, Pedra Branca, Eddystone Rocks and Black Pyramid (Brothers, 1979; MacDonald and Green, 1963; Warham and Serventy, 1978); estimates appear to resemble the Victorian total and the species' population is about 35 000-36 000, mostly in New Zealand (Nelson, 1978).

Silver Gull

Though many thousands of pairs nest on the Mud Islands, other colonies hold less than a thousand pairs, e.g. at Skerries Rocks (c. 20 pairs, Barton, 1978), Killarney Reef (500 pairs, Bowker, 1980a). Colonies have also been recorded at Crags, Altona Saltworks, Shoal Inlet and near St Margaret Island in Corner Inlet (Kay, 1978), and there are doubtless others. Opportunistic nesting may take place on the Promontory islands, since breeding has now been recorded on 13 islands in the past 20 years.

Breeding was first recorded on the Mud Islands in 1952, 120 young were recorded in 1961 and 3 000-4 000 pairs now breed there (Kerry and Hall, *in press*). This rapid increase may have resulted from residential development on Mornington Peninsula (Kerry and Hall, *in press*) but is probably also associated with the ability of the species to breed into autumn and winter (thousands were breeding in July 1973, F. I. Norman, unpublished data), which may represent extended nesting, or double-brooded birds (cf. Nicholls, 1964).

There are some 30 000 breeding pairs on coastal islands off New South Wales (Lane, 1979a), and the species is widespread throughout the continent with some breeding colonies well inland (Serventy *et al.*, 1971).

Pacific Gull

We found over 400 pairs of Pacific Gulls on the islands off Wilsons Promontory, and a pair at Cape Woolamai, Phillip Island. Serventy *et al.* (1971) list no Victorian breeding sites (probably the result of a lack of observers) and they suggested an apparent decrease in numbers and reduction in range in eastern Australia.

Kelp Gull

The Kelp Gull has invaded Victoria within the last decade; R. M. Warneke (*pers. comm.*) noted them first breeding on Seal Rocks in 1969. There are 12-15 breeding pairs on New South Wales islands (Lane, 1979a), and this species may be displacing the Pacific Gull in Tasmania (J. H. Calaby in Green, 1977).

Caspian Tern

The species was found breeding only on the Mud Islands (8 pairs), though numbers and colony location fluctuate annually (Kerry and Hall, *in press*). The species has also bred on Ram Island (in 1976, RAOU Nest Records), Bird Island, Lakes Entrance, Wingan Inlet, Mallacoota Inlet (Dorward, 1976), Cape Bridgewater, Stingray Bay and Bird Island (Kay, 1978) but these sites were not surveyed in 1978. No colonies are known in New South Wales and Serventy *et al.* (1971) showed most occurring in Western Australia. The Victorian population can only be small by comparison.

Crested Tern

There were 800-1 000 pairs of Crested Terns breeding on the Mud Islands in 1978, and six pairs on Seal Island. Some 40 pairs bred on Seal Rocks in 1966, but only six pairs in 1978 (R. M. Warneke, *pers. comm.*). The species has also bred on Killarney Reef (200 pairs, Bowker, 1980a), the Skerries (up to 500 pairs, Barton, 1978, 1980), on a shoal near St Margarets Island (A. H. Corrick, *pers. comm.*), and on Rabbit Rocks (Gillham, 1961). Thus the state has considerably less than the 13 000 breeding pairs estimated for New South Wales (Lane, 1979a).

Other species

Only two breeding colonies of the Black-faced Shag were found in 1978, at Notch Island and on one of the Twelve Apostles. Breeding has also been reported in the Bay of Islands (Serventy, *et al.*, 1971), and on Dannevig Island in 1979 and Skull Rock (Lane, 1979b, 1980). The species is restricted to southern Australia, where Serventy *et al.* (1971) listed only 34 breeding sites (and noted that fishermen were destroying birds and nests). However, the absence of recorded breeding sites in Victoria may reflect only a lack of observations at appropriate times.

No nesting Little Terns *Sterna albifrons* or Fairy Terns *Sterna nereis* were found, but the species have been recorded nesting around the coast in small numbers (Kay, 1978). Kay (1978) listed 11 Victorian breeding sites for the Fairy Tern and two birds were seen on the Mud Islands where 10-20 pairs are usually recorded (Kerry and Hall, *in press*).

3. BREEDING HABITAT OF VICTORIAN SEABIRDS

At most sites details of the vegetation within colonies were collected and burrow densities were determined within quadrats placed in different types of vegetation. The areas of such vegetation types occupied by colonies of Little Penguins, Short-tailed Shearwaters, and White-faced Storm Petrels were also frequently obtained. Some details are summarised below (Tables 3-5) and others given in Harris (1979). Differences in totals given below are due to differing levels of data collection and to the inclusion of subdominant plant species within communities dominated by other species.

Little Penguin

Most of the Victorian colonies visited during this survey, or listed elsewhere, are on islands. Mainland colonies (Portland, Warrnambool-Port Campbell area) were small and located in inaccessible bays usually at the base of cliffs, places which provide sheltered landing and, presumably, few terrestrial predators. Nest sites were most commonly found under granite boulders or *Poa poiformis* tussocks. On 24 of the islands, breeding was recorded under or among rocks on 14 and under *Poa* on 11 islands. The distribution of breeding sites reflects the distribution of appropriate habitat. There are, for example, few islands or promontories between Wilsons Promontory and Gabo Island, and colonies to the west are similarly restricted. It seems likely that the distribution

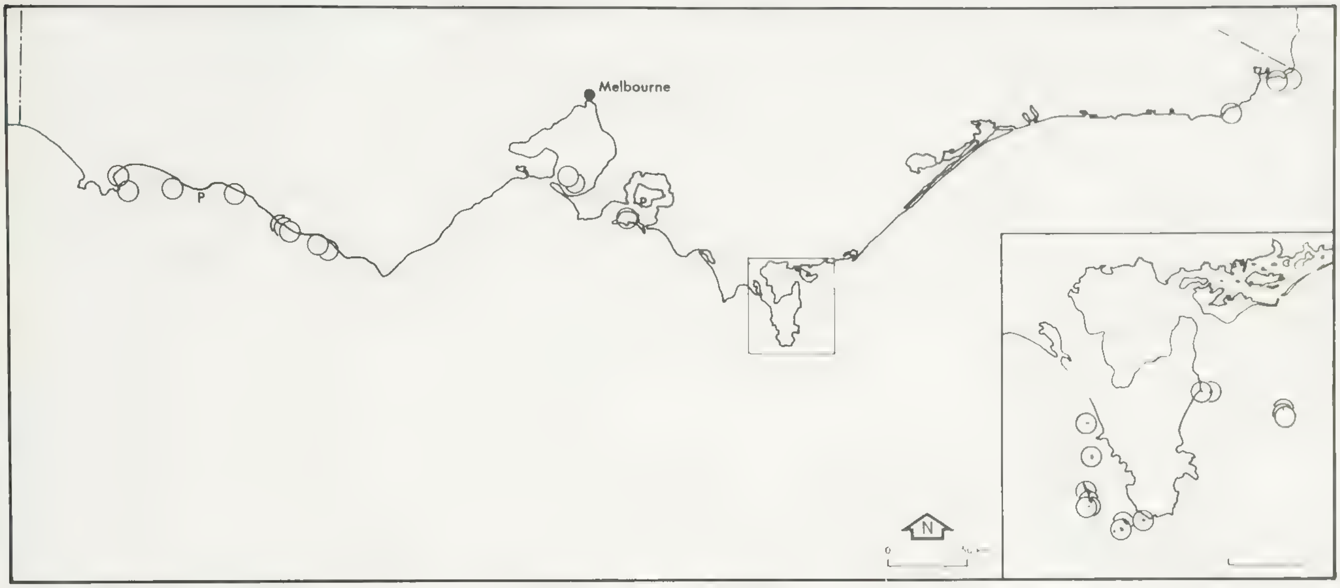

Figure 3. Location of breeding colonies of Little Penguins in Victoria.

TABLE 3

Major vegetation or 'habitat' types in colonies of Short-tailed Shearwaters on 21 Victorian islands (excepting Phillip and French Islands) visited in 1978; mean burrow density, burrow totals and soil depths are also shown.

Vegetation dominated by	Area (ha)	Number of islands	Mean burrow totals
Poa poiformis	211.2	16	1066157
Lavatera	35.1	2	93118
Ammophila	15.8	1	40100
Casuarina	12.2	1	7976
P. poiformis + rocks	11.6	1	29259
Mixed scrub[a]	9.4	1	27927
Tetragonia + *Rhagodia*	5.1	1	15759
Senecio lautus	4.6	1	6677
Carpobrotus	4.4	2	2027
P. poiformis + *S. lautus*	3.6	2	18578
Grassland[b]	3.1	2	2219
Tetragonia	2.9	1	5287
Carduus tenuiflorus	2.9	1	1752
Poa + *Tetragonia*	2.2	1	8550
Senecio + other spp.	1.8	1	5522
Heath[c]	1.2	1	751
Poa + other spp.	0.9	1	2503
Lepidium	0.7	1	6069
Scirpus	0.6	1	519
Bromus + other spp.	0.6	1	1915
Other spp.	0.3	1	518

[a] = Great Glennie.
[b] = Lady Julia Percy Island (see Norman *et al.*, 1980); Gabo Island.
[c] = Great Glennie.

TABLE 4

Major vegetation categories in quadrat samples within colonies of Short-tailed Shearwaters on Phillip Island, 1978. Mean burrow densities/m² are also shown.

Vegetation dominated by	Number of colonies	Mean burrow density/m²	Number of quadrats
Tetragonia implexicoma	12	0.16	48
Ammophila arenaria	10	0.13	132
Hordeum + other sp.	7	0.32	15
Juncus sp.	7	0.16	28
Bromus + other sp.	7	0.21	28
Carduus + *Silybum*	7	0.17	8
Arctotheca calendula	6	0.33	60
Leptosperma gladiatum	6	0.21	32
Rhagodia baccata	6	0.13	18
Silybum marianum	6	0.18	19
Stipa elatior	5	0.26	76
Other species	16	0.19	747

of islands or similar nesting areas limits the population rather than availability of nesting sites, since apparently suitable areas were not being utilised.

Short-tailed Shearwater

Naarding (1980) reported that only 25 of the 133 Tasmanian colonies known to him were on

TABLE 5

Life-forms and habits of plant species found in sample quadrats in Short-tailed Shearwater colonies. (Following Black, 1960-1965; Gillham, 1960; Willis, 1970, 1972).

	Total	No. alien	Annuals	Biennials	Perennial	Woody
Phillip Island	24	13	6*	6	16	3
Other Colonies	28	4	4*	3	24	7

*Included here are species which may be annual or biennial

the mainland, and in Victoria most shearwater colonies visited during this survey were on islands (including Phillip and French Islands); the few mainland colonies on headlands or promontories were small. On 21 of these islands, 21 vegetation types were recognised in the colonies (Table 3) but most colonies included areas of *Poa poiformis* (Naarding, 1980 also found that most Tasmanian colonies had tussock grass, and this provided the most abundant cover). Of the c. 330 ha of colony area considered here, 211 ha (64%) was covered by *Poa*, and held 1 066 000 burrows (79% of total in Table 3). The only other plants to dominate large areas of colonies were *Lavatera* (on Great Glennie and Anser Islands), *Ammophila* (Griffiths Island) and *Casuarina* (Great Glennie Island). Dominance by other plant species was generally restricted to small areas of colonies on the islands. On Phillip Island (Table 4), an area probably more affected by human activities than others, a different range and greater variation in dominant species was found, but in all colonies there the vegetation was characteristically of alien species (13 of 25 dominant in quadrats), and perennials (16); few woody plants (3) were present, and no heath species were recorded (Table 5). In contrast, species found on island colonies were generally native, and perennial; more woody species were also recorded.

The relationship between the shearwaters and vegetation in the nesting areas is complex and presumably dynamic (see Gillham 1960, 1961, 1962 for further details). Only plants tolerant of the birds' trampling, burrowing and excretion can exist in dense colonies. However, the vegetation may itself restrict distribution of burrows as the birds are limited, generally, to areas dominated by fine and short-rooted species. Burrowing beneath trees and shrubs was restricted to areas of sandy loams.

Successful burrowing is also limited to areas of soil sufficient for maintenance of nest sites. Within colonies burrow distribution was related to soil depth, the shearwaters requiring about 30 cm of soil in which to establish burrows. Soil depth was greater under *Lavatera* (on Glennie Island), *Poa* and *Lepidium*, and burrow density tended to increase with increased soil depth. Inclusion of surface or sub-surface rocks and boulders modified this tendency. Increased burrow density itself may lead to erosion, as a result of increased soil instability and destruction of plant cover and binding. Such destruction may also allow the invasion of ephemerals which become established in the non-breeding season only to die off in the drier seasons, during the birds' occupancy of the area. Extensive eroded areas (for example on Great Glennie, previously dominated by *Poa*) which have burrow densities similar to neighbouring uneroded areas may only be temporary stages before burrows collapse, thus reducing breeding success and subsequently burrow density.

Most of the island colonies (apart from those on Phillip Island) appear to have reached a maximum size and density, and in some areas unsuitable open nest sites are used. Any major expansion of the Victorian population can only be by colonisation of suitable mainland areas which are generally restricted and where they may be subject to increased predation by dogs, cats and foxes (e.g. Point Danger, Learmonth, 1965).

White-faced Storm Petrel

Storm petrels were found breeding only on three islands. On the Mud Islands the main breeding colony, in sandy soil admixed with coarse shell fragments and aeolianite, was dominated generally by *Glaucium flavum*, and the smaller colony was under *Atriplex cinerea*, whereas on South Channel Island the species was nesting in sandy loam dominated by *A. cinerea*, *Rhagodia baccata*, and *Tetragonia implexicoma*. On Tullaberga Island most burrows

were in areas of *R. baccata* and *A. cinerea*. Burrow density was highest in *Rhagodia* ($1.4/m^2$), where soil depth averaged 0.16 m (n = 31).

Shearwaters were not present in any storm petrel colony, a feature noted on others in Bass Strait islands (Gillham, 1963), though elsewhere in Australia the species are sympatric (Serventy *et al.*, 1971). The species may be restricted to more low-lying islands of which there are few around the Victorian coast.

Fairy Prion and Common Diving-Petrel

Nests of both species were found among basalt and granite boulders and rocks but some burrows were excavated under *Carpobrotus*, and Gillham (1961) recorded diving-petrels under *Poa* and *Scirpus* on Dannevig and McHugh Islands. On most islands these species nested in very shallow soil or among boulders, areas quite unsuited for shearwaters. However, scarcity of nest sites is unlikely to limit the species' populations in Victoria.

Other species

All Pacific Gull nests were on isolated islands, as were breeding pairs of Kelp Gulls, and colonies of Black-faced Shags. Terns found during the survey were on sandy beaches or rocks on islands, but elsewhere in mainland Victoria some terns nest on more isolated sand or shingle beaches. Habitat does not appear to restrict the breeding of terns, or the Silver Gull (which breeds in various locations around the coast), in Victoria.

4. THREATS TO THE BREEDING HABITAT

For successful breeding, seabirds require a secure nesting site and an adequate and assured food supply. Most Victorian colonies are on offshore islands where, until European man arrived, there were few if any mammalian predators. The larger marsupial carnivores (*Dasyurus, Sarcophilus*) have not been recorded from the smaller Bass Strait islands (Hope, 1973), but they do co-exist with colonies of shearwaters on the Tasmanian mainland where their role as predators of colonial-nesting seabirds seems to be minimal and Naarding (1980) considers feral cats to pose a greater threat. Indeed Serventy *et al.* (1971) suggested that seabirds select islands only if they provide sufficient visual expanse of surrounding sea. For whatever reason most species select islands for nesting and, for some species, distribution may be limited by their availability.

The main threats to the seabirds' requirements are as follows:

Destruction of habitat

At more accessible shearwater colonies nesting habitat has either been eliminated (e.g. Warrnambool area) or is being modified (e.g. Phillip Island), but as yet effects on the total populations have been minimal. Whilst some colonies have disappeared (e.g. penguins and shearwaters on Phillip Island), other areas have, apparently, been colonised recently (e.g. French Island). However, further change in land use may seriously affect the viability of other colonies. About 60 and 20 per cent of the breeding burrows of shearwaters and penguins are in National Parks. Faunal Reserves controlled by the Fisheries and Wildlife Division contain virtually all Victorian breeding gannets, about 33 per cent of the storm petrels, 25 per cent of shearwater burrows and 10 per cent of the estimated penguin burrows. Land administered by the Commonwealth Department of Transport contains about 40 per cent of Victoria's penguins. Most of the other colonies are on Crown Land, in foreshore reserves controlled by local authorities, or on islands where isolation gives protection from some forms of habitat disturbance. Though most colonies are on 'reserves', and theoretically enjoy official protection, the security of such colonies is often neglected.

Habitat degradation is also caused by the birds themselves burrowing in unstable soil; fires, grazing (by rabbits or cattle), or trampling (by cattle, and by humans) increase the risk of soil erosion.

Predation

The decline of the Cat Island (Furneaux Group) gannetry has been attributed primarily to human predation and vandalism (Nelson, 1978; Warham and Serventy, 1978), and Lawrence Rocks now appears to be the main Australian colony. Whilst penguins (and perhaps shearwaters) are taken for use as craypot bait in Bass Strait, and young shearwaters for food (legally in Tasmania but ille-

gally from Victorian islands), there is no evidence to suggest that such predation is now influencing populations.

Feral or pet dogs have caused locally severe mortalities in penguin and shearwater colonies (e.g. Middle and Merri Islands; Grossard Point and Cape Woolamai, Phillip Island) as do foxes (Point Danger, Benison Island). Though foxes have little impact on the breeding population (Norman, 1971), the numbers should be controlled and the effects of feral cats warrants investigation.

Disturbance

Human disturbance in colonies may be inadvertent, but as recreational activities increase, with increased leisure time, inevitably more accessible colonies will be affected. For instance at the Mud Islands in 1976 and 1977 a total of 843 visitors from 176 boats were recorded on 16 days and, although few people deliberately walked through storm petrel colonies, all could affect nesting terns or gulls (Venn, 1979) as could bird watchers, banders or amateur photographers. At more sensitive colonies, visitors should have limited access during breeding seasons and instructive displays should be available. Indeed at one site, Penguin Parade on Phillip Island, visitors have been controlled, and the penguins have become a tourist attraction with some 62 000 visitors in 1963-64; 88 000 in 1970-71, and 144 400 in 1976-77 (per B. West).

Some 'mainland' colonies suffer from a range of adverse factors, which may have varying effect on breeding success and breeding habitat. Thus the colonies (penguin and shearwater) at and near Griffiths Island have been or are being influenced by human disturbance and destruction of birds and burrows, predation (dogs and foxes) and modification of habitat (including physical elimination of breeding areas) (for some details see Bowker, 1980b). Similar factors affect colonies on Phillip Island (Harris and Bode, 1981).

5. THREATS TO THE MARINE ENVIRONMENT

Little is known of the interrelationships existing between seabirds and the marine environment. Whilst there is some agreement that food itself may limit population size, there is still dispute as to whether it is most influential near the breeding colonies (e.g. Ashmole, 1963), or when birds are not breeding (Lack, 1966; Diamond, 1978). However, some factors which might influence Victorian seabirds, both those breeding within the state and those using off-shore waters as non-breeding habitat, are readily apparent.

Food availability

Bass Strait and adjoining waters are amongst the more productive marine waters around Australia (Serventy *et al.*, 1971) and support large numbers of fish, crustacea and cephalopods on which seabirds feed (Blackburn, 1950; Roughley, 1961). The existing commercial fishery probably does not yet affect stocks of most fish species. And even if it had, the initial results might be to increase the number of small fish and thus benefit the seabirds. However, intensification of the industry or the development of markets based on smaller fish could influence populations of seabirds in Victorian waters as it has elsewhere (e.g. Crawford and Shelton, 1978; Frost *et al.*, 1976; Idyll, 1973; Nelson, 1978). In Victoria the Little Penguin appears to suffer from food shortages in some years (Reilly, 1977b; Reilly and Kerte, 1978), and there is a need to understand the interrelationships between the birds and prey species before any larger-scale fishery is developed.

In addition, the influence of modification to freshwater discharges into coastal areas of Victoria should be examined since localised hydrographic variations may alter the distribution of prey species taken by seabirds.

Oil and toxic chemical pollutants

Oil or toxic chemical pollution may represent the largest threats to seabirds (Bourne, 1976; Nettleship, 1977). The Bass Strait oil-field has developed markedly during recent years: production of crude oil has increased from about 7.8 million kilolitres in 1970 to 25.8 million in 1977 (Doran, 1979). Although this is piped ashore (with low probability of spillage), increasingly oil will be shipped into Victoria from other fields and contingency plans should allow for possible major spillages. Whilst the ocean currents around Victoria and Tasmania are generally west to east during winter and sum-

mer (Serventy *et al.*, 1971) the system is complex. Indeed Pollock (1971) has suggested that the interchange between oceanic and Bass Strait waters may be restricted for periods, and this could present serious consequences for pollution control. Additionally, surface oil can be moved by prevailing winds which need not act in concert with water movement.

In the event of such spillages Little Penguins would probably be most at risk; indeed already some oiled penguins have been found at Gabo Island (Reilly and Kerte, 1978). In recognition of this, Kay (1978) has suggested that dispersants should be used to protect penguins' breeding colonies, despite their detrimental effects to other marine organisms. Feeding flocks of shearwaters, often extremely large, may also be susceptible during their breeding seasons.

Pollution caused by toxic chemicals is usually detectable only after massive mortalities. Data on the occurrence and the effects of such chemicals (PCBs, DDT, heavy metals) in the marine environment are fragmentary and often conflicting (e.g. Bourne, 1976), and their sublethal effects are generally unknown. Concentrations of such pollutants in local seabirds have not been examined, and monitoring programs to rectify this situation should be initiated.

Conclusion

Most colonies of seabirds around the Victorian coast appear secure at present but in some areas breeding habitat is being either reduced or restricted by land use practices. No seabird population is under immediate pressure but colonies near centres of population, and having a tourist and educational value, require further management to enhance these values. Factors which might influence either the size of breeding populations or their productivity, such as pollutants, food availability and fisheries, require further examination.

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APPENDIX 1

Survey methods and summary of field data collected, from individual islands. (Publications presenting details are also indicated).

Lady Julia Percy Island (visited 27-30 Nov. 1978; 23-25 Jan. 1979). Little Penguin: dense colonies in talus, Dinghy Cove and Seal Bay (total counted 351 burrows); scattered colony above Seal Bay (burrow density × area, 1600 burrows); some 2000 burrows in total. Fairy Prion: not surveyed, widely distributed and perhaps thousands of pairs. Short-tailed Shearwater: numerous colonies, numbers estimated by direct counts, by the product of burrow densities and areas (using quadrats), and by subsampling and counting; estimated 15 300 burrows. Common Diving-Petrel: not estimated, but nesting in at least five areas. For further details see Norman *et al.* (1980), and Pescott (1976).

Lawrence Rocks (1 Dec. 1978)
Little Penguin: direct count of 109 burrows.

Fairy Prion: estimate only, of less than 200 breeding burrows. Common Diving-Petrel: dead young found. Australasian Gannet: direct count of 1 456 nests. See Pescott (1980) for further information.

Griffiths Island (25-26 Nov. 1978).
Short-tailed Shearwater: burrow densities from 59 quadrats (3.14m²), estimate of c. 43 400 burrows using density × area; a further 8 700 burrows at the Southcombe and Peasoup colonies on the adjacent mainland. Further details in Bowker (1980b) and Harris (1979).

Middle and Merri Islands (1 Dec. 1978).
Little Penguin: direct count of 199 and 10 burrows.

Mud Islands (22-23 Nov. 1978).
White-faced Storm Petrel: main colony estimated using lines to determine area, subsampling in quadrats (123 of 20m²; 32 of 3.14 m²) to find burrow density which varied between 0.1-1.3/m²; population estimated at 5 600 burrows (95% confidence limits 4 400-6 900), a further 198 burrows counted elsewhere. Silver Gull: some thousands of pairs; Kerry and Hall (*in press*) suggested 3 000-4 000 pairs. Caspian Tern: 8-10 pairs counted. Crested Tern: estimate of 800-1 000. See Harris (1979) and Kerry and Hall (*in press*).

South Channel Island (10 Nov. 1978; 21 June 1979).
Little Penguin: D. R. Venn (*pers. comm.*) found 30-40 pairs.
White-faced Storm Petrel: occupied 3300m², burrow density 2.05/m² in 40 quadrats (3.14m²); estimated 6 800 (6 000-7 600) burrows. Silver Gull: 7 nests counted. Details in Harris, Deerson and Brown (1980a).

Harbour Light (Wedge) Platform (10 Nov. 1978).
Australasian Gannet: count of 28 nests.

French Island (30 Oct. 1978).
Short-tailed Shearwater: dense colony in *Tetragonia, Carduus* and grasses, small colonies elsewhere on Tortoise Head, counts and quadrats (17,20m²) used to produce estimate of 3 100 burrows.

Phillip Island (24 Oct.-3 Nov. 1978).
Little Penguin: burrows counted in small colonies, otherwise 20m² quadrats or 2m-wide transects used; number of used burrows of the order of 6 000, mainly at the western end of the island. Short-tailed Shearwater: colonies distributed along some 26 km of southern and western coast, boundaries drawn on aerial photographs and areas determined; burrows counted in small colonies but elsewhere burrow densities determined from 20m² quadrats (735); estimate 542 300 (439 300-645 300) with 356 000 at Cape Woolamai. Silver Gull: nests counted or estimated at Seal Rocks (250-300 pairs), the Nobbies (c. 200 pairs), Purple Rock (150-200 pairs), and Cape Woolamai (80-130 pairs). Pacific and Kelp Gulls: count of one pair (Cape Woolamai) and three pairs (Seal Rocks) respectively: Crested Tern: six pairs on Seal Rocks. Further details in Harris and Bode (1981).

Granite Island (17 Oct., 6 Nov. 1978).
Short-tailed Shearwater: Burrow density in 0.75 ha *Poa poiformis* 0.3/m² (3.14m² quadrats), estimate of 2 020 (1 610-2 430) and a further 100 burrows in bare ground. Further details in Norman (1977a).

Benison Island (17 Oct., 7 Nov. 1978).
Short-tailed Shearwater: most burrows in *Poa-Senecio lautus* (1.01 ha), density 0.46/m² (28 quadrats, 3.14m²); others in mixed *Poa, Pteridium esculentum, Lomandra longifolia* and *Pelargonium australe* (0.94 ha), density 0.27/m²; estimate of 7 200 (5 930-8 400). Norman (1977b) provided some earlier details.

Doughboy Island (17 Oct., 7 Nov. 1978).
Short-tailed Shearwater: most burrows north of central ridge, population in 0.6 ha estimated at 2 000 (1 600-2 400) using burrow density 0.3/m² (22,20m² quadrats), few elsewhere. Silver Gull: 84 nests counted, others estimated. Earlier details in Norman (1977c).

Shellback Island (13 Dec. 1978).
Little Penguin: not counted, perhaps several hundred burrows. Fairy Prion: dead birds found. Short-tailed Shearwater: burrow density on slopes (21,20m² quadrats) 0.2/m² (24.5 ha) and 0.48/m² (30 quadrats) on flatter top (12.3 ha); estimate of 109 500 (87 400-131 600). Common Diving-Petrel: a dead bird found. Pacific Gull: not counted, about 100 pairs

thought to be breeding. Further details in Harris, Deerson and Brown (1980b).

Norman Island (17 Jan. 1980).
Little Penguin: not counted but Lane and Battam (1980) estimated 400-500 pairs. Fairy Prion: dead birds found. Short-tailed Shearwater: burrow density in *Poa* (20.75 ha) 0.7/m² (28 quadrats, 20m²), population estimated at 145 000 burrows (131 350-158 500). Common Diving-Petrel: three nests found. Silver Gulls: 85 pairs considered present. Pacific Gull: estimated 35 pairs present. Further information in Lane and Battam (1980) and Norman *et al.* (1980 b,d).

Great Glennie Island (7-10 Dec. 1978).
Little Penguin: not counted but considered to be of the order of 500 pairs. Fairy Prion: one found dead. Short-tailed Shearwater: 518, 20m² quadrats taken over island in varying vegetation, estimate 400 300 burrows (334 500-456 300). Silver Gull: estimated as 100 pairs breeding. Pacific Gull: three nests found, about 10 pairs with territories; B. Robertson saw 30 birds in November 1979, and found 3 nests. Harris (1979) and Harris, Brown and Wainer (1980) give further details.

Dannevig Island (17 Jan. 1980).
Little Penguin: not estimated but few burrows found. Fairy Prion: birds found dead and Lane (1979b) found nests. Short-tailed Shearwater: burrow density in *Poa* (6.49 ha) 0.7/m² (15 202 quadrats), estimate 44 600 (37 800-51 300). Common Diving-Petrel: breeding, recorded by Lane (1979b). Black-faced Shag: Lane and Battam (1980) recorded 30 birds on nests in November 1979, and young were present in January 1980. Silver Gull: 10-12 pairs counted. Pacific Gull: c. 20 pairs estimated. See Norman *et al.* (1980 a,d).

McHugh Island (11 Dec. 1978).
Little Penguin: 11 burrows found in quadrats (50, 20m²) used to provide estimate of about 1 000 burrows. Fairy Prion: nests found by Lane (1979b). Short-tailed Shearwater: burrow density 0.16/m² in *Poa* (3.9 ha; 50, 20m² quadrats) providing estimate of 6 200 burrows (4 500-7 900). Pacific Gull: one pair present; B. Robertson found 4 nests in November 1979. See Harris and Deerson (1980a).

Citadel Island (11 Dec. 1978; 13 Feb. 1979).
Little Penguin: 45 burrows counted. Fairy Prion: about 50 burrows counted. Short-tailed Shearwater: 111 burrows counted. Common Diving-Petrel: a dead bird found. Pacific Gull: old sites recorded by Lane (1979b) in 1978 and flying young seen in 1979. See Norman and Brown (1979, 1980).

Anser Island (11 Dec. 1978).
Little Penguin: estimate of several hundred pairs. Fairy Prion: burrows found but no estimate made. Short-tailed Shearwater: 122, 20m² quadrats taken in various vegetation types; burrow densities (highest in *Poa*, 0.6/m²; lowest in *Lavatera* 0.2/m²) multiplied by areas gave 251 700 burrows (216 200-287 100) (but here the extreme slope of parts of the island would markedly increase areal measurement). Silver Gull: one pair counted. Pacific Gull: 20 breeding pairs estimated. See Harris (1979), Lane (1979b) and Harris *et al.* (1980).

Kanowna Island (13 Dec. 1978).
Little Penguin: not surveyed. Fairy Prion: ten dead birds found. Short-tailed Shearwater: 30,20m² quadrats in *Poa* (4 ha) held 0.56 burrows/m² or 22 700 (19 300-26 000) in total; 29,20m² quadrats (in 11.6 ha) had 0.28 burrows/m² giving a mean of 29 300 (19 000-39 500). White-faced Storm Petrel: one dead bird found. Silver Gull: one pair with young counted. Pacific Gull: nests and estimate giving total of about 100 pairs. See Harris and Deerson (1980b).

Wattle Island (12 Dec. 1979).
Little Penguin: not counted but may be of the order of 1 000 pairs. Fairy Prion: corpses found. Short-tailed Shearwater: burrow density in *Poa* (9.6 ha) 0.81/m² in 30,20m² quadrats, 0.5/m² in 5,20m² quadrats in *Disphyma australe* (1.1 ha); estimates of 77 750 (72 000-83 500) and 5 700 (2 650-8 900) burrows respectively. Common Diving-Petrel: corpses found (see also Lane and Battam 1980). Silver Gull: count of 68 nests. Pacific Gull: nests 30 found. See Lane and Battam (1980) and Norman, Brown and Deerson (1980 c,d).

Rabbit Island (5, 10 Dec. 1978; 10 Dec. 1979).
Little Penguin: estimate of 500 burrows. Short-tailed Shearwater: 136,20m² quadrats provided

average burrow density 0.48/m² and island total of 131 000 (115 200-146 600) burrows. Silver Gull: 27 nests counted in 1979. Pacific Gull: five nests found in December 1979. See Norman and Harris (1981), and Norman *et al.* (1980).

Rabbit Rocks (21 Dec. 1978).
Little Penguin: estimate of about 100 pairs. Short-tailed Shearwater: occupied 0.55 ha; burrow density 0.68/m² in 25,20m² quadrats giving burrow total of 3 800 (3 200-4 300). Pacific Gull: 2 pairs present. See Harris and Deerson (1980g) for further details.

Seal Island (21 Dec. 1978).
Little Penguin: not counted but some hundreds of burrows. Fairy Prion: not counted, perhaps several hundred pairs. Short-tailed Shearwater: 0.47 burrows/m² in 11.33 ha *Poa* (30,20m² quadrats), burrow total 54 000 (46 800-60 400). Common Diving-Petrel: dead adults and young found. Silver Gull: 20 pairs estimated. Pacific Gull: 100 pairs estimated. Crested Tern: count of six pairs nesting. See Harris and Deerson (1980d).

Notch Island (21 Dec. 1978).
Little Penguin: estimate of about 500 burrows. Fairy Prion: small colony, burrows not counted. Short-tailed Shearwater: burrow density in 23,20m² quadrats was 0.2/m² in northern colony (1.6 ha), burrow total 3 300 (2 700-3 900); density 0.28/m² in 22,20m² quadrats in southern area (0.97 ha) and total 2 700 (1 900-3 400) burrows. Common Diving-Petrel: live young found. Black-faced Shag: some 20 unfledged, and about 100 juvenile, birds present. Silver Gull: count of five pairs breeding. Pacific Gull: estimate of ten breeding pairs. Further details given in Harris and Deerson (1980c).

Cliffy Island (21 Dec. 1978).
Short-tailed Shearwater: main colony in 0.9 ha *Poa*, burrow density 0.61/m² in 20,20m² quadrats or 5 300 burrows (3 800-6 700); 508 burrows counted in about half remaining *Poa* area, island burrow estimate about 6 300. Silver Gull: one pair counted. See Harris and Deerson (1980e).

Rag Island (21 Dec. 1978).
Little Penguin: not counted but hundreds of burrows present. Short-tailed Shearwater: 31,20m² quadrats in *Poa* (2.67 ha) gave a burrow density of 0.68/m² and thus 18 200 (16 100-20 300) burrows. Common Diving-Petrel: one dead young found. Silver Gull: estimate of 20 pairs. Pacific Gull: estimate of at least 5 pairs breeding. See Harris and Deerson (1980f).

Tullaberga Island (16 Nov. 1978).
Little Penguin: 0.04 burrows/m² in 25,20m² quadrats taken in *Poa* (0.5 ha) where burrows totalled 180 (100-260); single burrow in 18,3.14 m² quadrats in *Rhagodia* (1.3 ha) added 230 to total. White-faced Storm Petrel: most burrows in *Rhagodia*, density 1.37/m² in 18,3.14m² quadrats; in *Atriplex* (0.1 ha) 0.76 burrows/m² (5,3.14m² quadrats) and in *Poa* (0.5 ha) 0.24/m² (25,20m² quadrats); estimate of 20 000 (14 304-25 850). See Harris, Brown and Deerson (1980).

Gabo Island (13-15 Nov. 1978).
Little Penguin: generally 20m² quadrats used, but also strip transects through scrub areas; c. 5 620 (3 720-7 330) burrows estimated in 438 quadrats (19.37 ha sampled) and 820 in 46.87 ha of scrub; small numbers counted; island may hold 5 000-10 000 burrows. Short-tailed Shearwater: one area counted, remaining colonies sampled by 20m² quadrats (248, in 5.84 ha); burrow total 7350 (5 000-9 400). Further details in Harris (1979), and Reilly (1977a).

AN ABORIGINAL VOCABULARY OF THE FAUNA OF GIPPSLAND

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Abstract

The words which four aboriginal tribes from Gippsland used for some species of mammals, birds, reptiles and amphibians are presented and discussed. Sources of information used were the records of early European explorers, settlers and persons interested in Aboriginal culture. Where possible, tentative phonetic renderings in practical orthography are provided. The use of such information to augment our knowledge of the original distribution of native fauna is discussed.

Introduction

In this paper we have compiled, from the records of 19th century European colonists, a vocabulary of names given to animals by the Aboriginals of Gippsland. These records represent, however sparsely, the first lists of fauna for this area. Only names for birds, mammals, reptiles and amphibians are included, but most of the literature consulted contains references to similar information for fish and vegetation.

The words listed are those of four tribes which were distinguishable by differences in language: the Krauatungalung, the Brabiralung, the Braiakaulung and the Tatungalung (Tindale, 1974). The approximate tribal boundaries are shown on Fig. 1 (Howitt, 1904; Tindale, 1940, 1974) but these became derelict when traditional Aboriginal society collapsed soon after European settlement. The Gippsland Lakes Catchment (G.L.C.) is also shown (Fig. 1) as a vertebrate survey of this area is discussed (Norris *et al.*, 1980).

Before the drastic reduction in population caused by European settlement (Rowley, 1972; Christie, 1979) the Aboriginal population of Gippsland has been estimated as between 1000 and 1500 people (Fison and Howitt, 1880). In a demographic study Barwick (1971) states that (i) the tribes of western Gippsland were 'remnant' by 1852; (ii) that the Gippsland population was apparently stable from 1863 to 1877 although there was some immigration from the Monaro area to Lake Tyers; and (iii) that a fairly high proportion of the Gippsland people were still camping away from the stations and a substantial number of old people continued to wander until the late 1890s. Aboriginal stations were started at Lake Tyers and at Ramahyuck in 1862 (Christie, 1979; Barwick, 1971).

Sources

The vocabulary has been compiled from published and unpublished data collected by various Europeans during the latter half of the 19th century. The histories and the motives of the European recorders (Table 1) are varied. Edward M. Curr (1820-1879) was an author and squatter, whose work on Aboriginal culture (Curr, 1857) was, according to Pike (1969), "only as reliable as the observations made by his helpers". In Gippsland these were Bulmer, Hagenauer and Howitt. John Bulmer (1833-1913) and Friedrich A. Hagenauer (1829-1909) were respectively Church of England and Moravian missionaries who had had extensive experience on Aboriginal stations in northwestern Victoria and Gippsland (Pike, 1969, 1972; Walker, 1971; Christie, 1979). Bulmer had some knowledge of natural history (Christie, 1979). Alfred W. Howitt (1930-1908), who lived in Gippsland as police superintendent, magistrate and scholar, provided many contributions to exploration, natural history and anthropology. His interpretations of Aboriginal culture have been criticized (Walker, 1971, p. 310) but not his skill as an observer.

Robert H. Mathews (1841-1918) was a surveyor and anthropologist who ". . . prided himself on ascertaining his facts from the Aboriginals themselves" (Pike, 1974). Most of his work was with tribes in New South Wales, Northern Territory and Central Australia (Greenway, 1963).

John Mathew (1849-1929) was an anthropologist interested in the Aboriginals of several areas of Australia. It is not known when either of the last two observers visited Gippsland.

Memoirs of the National Museum Victoria,
No. 42, 1981.

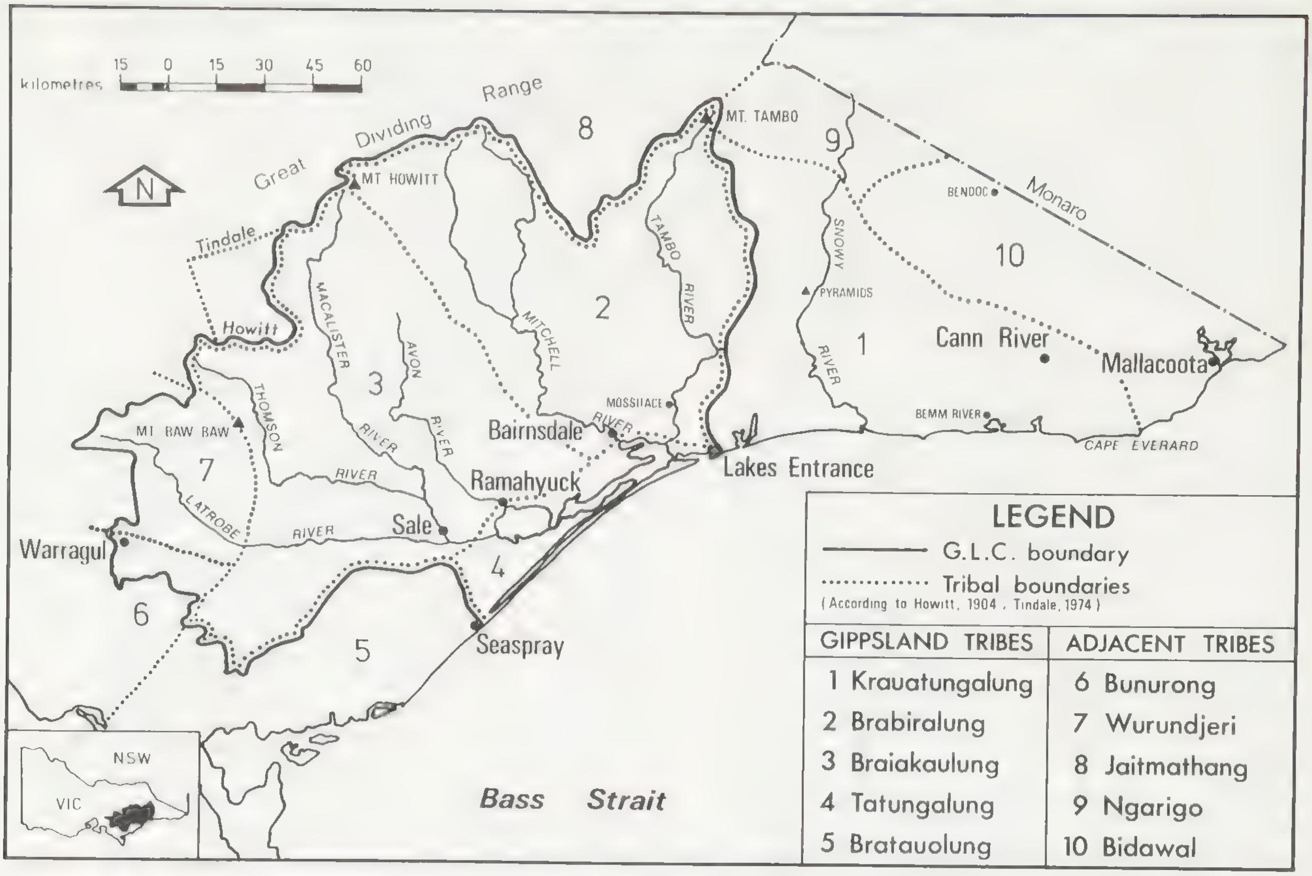

Fig. 1. Tribal boundaries of the Aboriginals of Gippsland, Victoria.

William Thomas (1793-1867) was appointed a Guardian of Aborigines and contributed much information to Smyth's *Aborigines of Victoria* (Smyth, 1878). William Dawson (?-1901) and J. Petitt (?-?) were the first Chief Surveyor of Gippsland and assistant respectively. Their list (Dawson and Petitt 1850s) also includes Aboriginal place names, some of which have been adopted in Gippsland.

Curr (undated) provides a list of words of the Krauatungalung tribe ('Lake Tyers'). These correspond to those provided to Curr (1887) by Bulmer and given in the vocabulary. Bulmer (undated, 1904) and Howitt (1895) also provide words that appear in the vocabulary under their respective names but have been derived from other sources. Howitt (undated) gives Aboriginal names to twenty vertebrates but the tribe or area where they were collected is not given. All words except that given for Quail (Tchure-wuk) correspond to Gippsland words recorded by Howitt or Bulmer. To avoid repetition these have not been included in the vocabulary. The Intercolonial Exhibition Commissioners (1867) have recorded words from Lake Tyer [sic]. However, as noted by Schmidt (1919) the language content demonstrates the list is derived from Thaguwurra (Upper Goulburn).

Explanation of Table and Layout of Vocabulary

In Table 1 each source of information is assigned a symbol by means of which the recorder of every word given in the vocabulary can be identified. The originally stated area inhabited by the tribe using each word and the name of the tribe are also given in Table 1 (columns 3 and 4).

TABLE 1

Sources

Source	Symbol	Area	Tribe (following Tindale 1974)
Anon (1847)	(A)	West Gippsland and Lakes area	Braiakaulung and Tatungalung
Curr (1887)	(C)	*Gippsland	
In Curr (1887)			
(i) Bulmer	(Bu)	Snowy River and *Gippsland	Krauatungalung and others see below
(ii) Howitt	(Ho)	*Gippsland	
(iii) Hagenauer	(Ha)	*Gippsland	
Dawson and Petitt (1850s)	(D)	Snowy River, Lakes Mitchell River, McMillan's Blacks	Krauatungalung, Brabiralung, Tatungalung, Braiakaulung
Howitt (1880)	(H)	Lake Tyers district	Krauatungalung
	(Hi)	Nulert	Nulit = Braiakaulung
	(Hii)	Mukthang	= Brabiralung
Mathew (1899)	(Ma)	Gippsland	?
Mathews (1902)	(M)	Gippsland (central)	Brabiralung ["Brabirrawulung"]
In Smyth (1878)			
(1) Bulmer	(Bs)	Lake Tyers	Krauatungalung ["Karnathun"]
	(Br)	Swan Reach	Brabiralung ["Bundah Wark Kani"]
(ii) Hagenauer	(Hs)	Lake Wellington	Tatungalung ["Tarrawarrackel"]
(iii) Thomas	(T)	Sale and Bushy Park	Braiakaulung
(iv) Howitt	(Ht)	Gippsland	"Brabralong [sic] and neighbouring tribes"

* This area as defined by Curr (1887) encompasses three tribes the Braiakaulung, Tatungalung and Brabiralung.

The first column in the vocabulary is ordered following Norris *et al.* (1980) and gives the species name and modern vernacular name to which we think the 19th century English vernacular names in column 2 refer. The corresponding Aboriginal words and the code for the European who recorded them are listed in column 3. *The spelling of words in columns 2 and 3 is that of the original recorder.* Phonetic symbols have been omitted but were used to help compile the tentative rendering in practical orthography in column 4 (see appendix 1 for notes on pronunciation). These appear in italics if they were recorded by one of us (L.A.H.) at the Lake Tyers settlement in 1964. Ambiguous words in column 3 have not been given a modern orthography. Words from other areas have appropriate footnotes.

Discussion

Interpretation is affected by four main uncertainties. Firstly, "the extraordinary isolation of this [Gippsland] tribe" (Fison and Howitt, 1880) was destroyed when Aboriginals from other areas, mainly the Monaro, were forced to settle on the two missions in East Gippsland. Some European recorders did not accurately identify, or at least record, the informant's tribe even though most recorders were ethnographers. For example, Hagenauer brought Nathaniel Pepper to Ramahyuck from north-western Victoria (Christie, 1979; Leslie and Cowie, 1977), an event which may explain a word from that area (see *Hirundo neoxena*), being recorded by Dawson and Petitt (1850s) who may have been unaware of Pepper's origins.

Secondly, the recorders were probably not as aware of taxonomic subtleties as were the Aboriginals who would also have had different criteria for classification. The catch-all English word 'snake' in the vocabulary corresponds to many Aboriginal words, one or two of which may be a generic equivalent of 'snake' (see Hercus, 1966), but most of which probably refer to one of at least seven species which occur in Gippsland (Norris *et al.*, 1980).

Thirdly, some Aboriginal names may have had totemic significance and consequently, any animal may have had different names used according to circumstance. Every Gippsland Aboriginal ". . . received the name of some marsupial, bird, reptile or fish from his father when he was about ten years old, or at initiation. A man would say, pointing to the creature in question, that is your *thundung*, do not hurt it" (Howitt, 1904). And finally, in many instances, the Europeans' inconsistency in the use of vernacular names of fauna has prevented an unequivocal interpretation of their meaning. "Iguana" might mean either "Goanna" or what is often called the "Gippsland Iguana", the Eastern Water Dragon.

The list of words reveal a small part of what was a deep involvement of Aboriginals with their environment. The interest of the few early Europeans has incidentally aided our knowledge of early Gippsland fauna by providing the first available faunal lists. *Thylogale billardieri, Conilurus albipes, Anseranas semipalmata, Grus rubicundus* and *Ardeotis australis* are no longer found in the area and *Petrogale penicillata* is rare and restricted to remote parts of the Snowy River Gorge (Norris *et al.*, 1980). From the documented occurrence of species (Norris *et al.*, 1980) it appears that mammals are the best represented Order in the vocabulary. This may be due to the bias of the original recorders. This group also has the highest proportion of words recorded in 1964.

A comprehensive description of the vertebrate fauna of the survey area is provided by Norris *et al.* (1980), but the following species deserve further comment.

Potorous spp. Potoroos.

Both *Potorous tridactylus* and the recently described *P. longipes* (Seebeck and Johnson, 1980) occur in the survey area. The known range of the latter is almost entirely in the tribal area of the Krauatungalung. 'Bri' and 'winnenerbree' are recorded for kangaroo rat in this language. Although unusual, the vocabulary evidences that this Aboriginal group appears to have used qualifying adjectives in animal names, see for example *Petrogale penicillata* and *Eudyptula minor*. Further linguistic investigation may show that the Aboriginal name of *P. longipes* was 'winnenerbree' (pron. winina-bri).

Thylogale billardieri Red-bellied Pademelon

This is a coastal species in Victoria. Five primary references to this species concerning the survey area have been located (Anon, 1894; Bury, 1966, 1967; Lewis, 1931, Le Souef, 1895). Although once plentiful around the Gippsland Lakes (Lewis, 1931; Bury, 1966, 1967) a Tatungalung word for the species was not recorded. This suggests that the lists compiled by the 19th century ethnographers were far from complete. The Krauatungalung tribe had a word for this species but there are no other records for this area although it was reportedly abundant at Mallacoota (Le Souef, 1895).

Conilurus albipes White-footed Rabbit-Rat

Howitt (1880) recorded the Braiakaulung word for Rabbit Rat. However, he omitted a Krauatungalung word after including the English common name in the species list of this tribe. Rabbit Rat has been applied to several species. However, only *C. albipes* is relevant to Gippsland (Troughton, 1973). Little is known about this species and it was already uncommon in Port Phillip (Victoria) in the 1800s (Gould, 1976). Wakefield (1972) recorded its subfossil remains in a cave at the Pyramids (see map) and commented that although the species was plentiful "probably until about 100 years ago" no live specimen had been recorded within 100 miles of that site. Subfossil bones of this species have been found on the Snowy River (Norris *et al.*, 1980; FWD records).

The National Musuem of Victoria (NMV) has two specimens of *C. albipes* originally registered as R 1103 and R 1104 (presently C 7586, C 7585 respectively). These were regis-

tered as "*Hapalotis albipes*—Cooper's Creek, Cent. Aust.—Howitt's Cooper's Ck. Colln." This information was derived from a list written no later than 1862 by John James, secretary and accountant of the Museum (Darragh, pers. comm.).

A search of the published and unpublished writings of Howitt concerning both Gippsland and Central Australia has failed to locate a reference to this species other than those given here from Gippsland. Cooper's Creek, Central Australia, appears an anomalous locality in regard to all other records that define the range of this species (Mahoney, pers. comm.). However during the course of the expedition to Central Australia Howitt did traverse areas that are within the perceived range and habitat of this species. From 1858 Howitt collected skins for the Museum around the eastern periphery of the survey area (Walker, 1971). In 1860-1 he led a party into Central Gippsland for the Prospecting Board (see map in Walker, 1971) which explored in the Braiakaulung tribal area. Howitt recorded the name for Rabbit Rat in this language. This circumstantial evidence suggests that the NMV specimens were probably collected in Gippsland.

Ardeotis australis Australian Bustard

Wakefield (1942) wrote concerning a record of this species from Mossiface. "The Bustard once used to visit the southern Monaro Plains and probably sometimes used to cross the border into the Bendoc district, but why a single bird should have been found so far from its natural habitat is beyond explanation". He was presumably unaware of earlier records of this species being a food source for Aboriginals and early settlers of Gippsland (Leslie and Cowie, 1977). Two observers have recorded the word (one of which may apply to a different species) which tribes of the Gippsland Plains used for the "Wild Turkey"; consequently the specimen Wakefield reported might have been a remnant of a Gippsland population, rather than a bird from N.S.W., as implied by him. Hunting pressure and habitat modification probably led to its dying out in this area. The same is possibly true of *Anseranas semipalmata*, the original occurrence of which is discussed by Norris *et al.* (1980).

Grus rubicundus Brolga

Flocks of this species were recorded around the lakes in the 1850s (Leslie and Cowie, 1977), but only once has the species been recorded this century (Garnet, 1944). Seven of the ten original recorders noted words for this species from the Krauatungalung and Brabiralung tribes. Apparently suitable habitat existed in every tribal area, but 36% of this has been eliminated or greatly modified since settlement (Corrick and Norman, 1980). Bulmer (undated) describes the Aboriginal legend that explains why the Brolga usually lays two eggs in contrast to the Emu that can lay many more.

Morelia spilotes Diamond Python

This species has been recorded at Mallacoota and Bemm River (Le Souef, 1896; Daley, 1917); the latter locality corresponds to the southern limit of range attributed to the species by Cogger (1979). If the interpretation of Wood (Snake) or Constrictor Snake and Carpet Snake as *Morelia spilotes* is accepted then this species was known to the Krauatungalung and Brabiralung tribes.

Conclusion

By recording Aboriginal names for native animals, early European colonists have given us the earliest fauna lists of the area. This vocabulary illustrated how such data, especially when used in conjunction with other information can be used to augment our knowledge of the distribution of these animals at about the time of settlement.

The problems and inadequacies in the use of such data have been discussed for this region but hopefully the benefits will encourage workers in other areas to pursue similar investigations where possible.

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FAUNAL VOCABULARY OF GIPPSLAND TRIBES

Mammals

(Presumed) Scientific Name	Common names used in original	Anglicised Aboriginal word used in original	Tentative phonetic rendering in practical orthography
Tachyglossus aculeatus Echidna	Porcupine (Bs,D,H,M,Ma)	Kowern (Bs) Kaern (H) Kauan (M) Kauon (Ma) Tarrangut (D)	*kowang* tarangat[?]
Ornithorhynchus anatinus Platypus	Platypus (Bs,D,H,M)	Barlijan (H) Barlijan (Bs) Jimmialong (D)	parlayan *djamalang**

* *djamalang* belongs to the adjoining languages to the east and north east. It was recorded in Ngarigu (Delegate area) by L.A.H. and is also attested by R. H. Mathews.

		Malungany (H) Mallunggang (M)	malangang
Dasyurus maculatus Tiger Cat	Tiger Cat (Bs,H)	Bindhalang (Bs,H)	*bindjulang* (see *D. viverrinus*)
D. viverrinus Eastern Quoll	Native Cat (Bs,H,M,)	Brumbri (deleted in original to) Yuri(H) Brumbin (Bs) Bindyallang (M)	*brambinj* *bindjulang* (see *D. maculatus*)
Phascogale tapoatafa Tuan	Tuan (H) *Phascogale penicillata* (Hi)	Warnda (H)	wernda (see *Petaurus australis* and *Acrobates pygmaeus*)
Peramelidae Bandicoots	Bandicoot (Bs,H,Hi,M)	Bunyil Wathin (Hi) Min nack (Bs) Menak (Bs,H,Hi) Mennuk and	minak
Vombatus ursinus Wombat	Wambat (H,Hii) Woombat (A) Wombat (Bs,S,M)	Bembung (M) Naroit (H) Narut (H,Hii) Narutt (A) Narrot (M) Naroot (Bs,S)	*bembang* *narut*
Phascolarcstos cinereus	Native Bear (Bs,H,M,Ma,) Native Sloth (A) Native Slothbear (Hii)	Culla (A) Kula (M,Ma) Gorla (H)	goorla

(Presumed) Scientific Name	Common names used in original	Anglicised Aboriginal word used in original	Tentative phonetic rendering in practical orthography
Koala		Gula (Hii)	
		Gooleur, Goola (D)	
		Kullah, Koola (Bs)	
Trichosurus caninus	Black Possum (Bs,H)	Brak (Bs,H)	brak
Bobuck	Black Oppossum (A,Hi)	Bruk (Hi)	
	Place of 'plenty black	Narburicgall (A)	narburigal
	possum' (D,Hs)	Nambruc (D)	nam-brak
T. vulpecula	Brushtail Opossum (H)	Wadthun (H)	*wathaan*
Common Brushtail	Opposum (A)	Wadhon (A)	
	Possum (D)	Wadthan, Wadgin	
	Opossum (Bs,Bu,C,Hi,Hii,	Wadgan (D),	
	Ho,Ha,Ht,M,Ma)	Watthan (Hi)	
		Wattham (M) Wadhan	
		(Ma)	
		Wajan, Wa-gin (Bs)	
		Wachan, Wadhan (Bu)	
		Waitun (C)	
		Wattung, wirrwy (Ho)	
		Wattun (Hi,Ht),	
		Karramook (Ha)	*kuremuk**

* *kuremuk* belongs to south-western Victoria. It was recorded in Gurdidj (Lake Condah) by L.A.H. and has been attested by R. H. Mathews in Bungandidj (Mt Gambier) and Dauhurtwaru (Portland).

		Koongora (C)	*kungara**

* *kungara* belongs to the adjoining coastal languages. Thoorga and Bidawal. It is given for both by R. H. Mathews and was recorded in Thoorga by L.A.H.

Psuedocheirus peregrinus	Ringtail Possum (H)	Blaang (Bs) blaang	
	Ringtail Oppossum (Bs)	Blang (H,Hi,M)	blaang
	Ringtail Oppossum (M)		
Common Ringtail	Ringtail (Hi)		
Petaurus breviceps	Flying Squirrel (Bs,H,M)	Weran	waarang
Sugar Glider		Waran (M)	
		Waran (Bs)	
P. australis/			
Schoinobates volans	Large Flying Squirrel (H,Bs)	Warnda (Bs)	wernda
Yellow-bellied Glider	Great Flying Squirrel (H)	Wernda (H)	
Greater Glider	Squirrel (A)	Warndaa (A)	
		Thathak-gaw (H)	
Acrobates pygmaeus [??]	Flying Mouse (Bs,H,Hi)	Tuan [with'?'(H)]	*toowan**
Feathertail Glider		Toan (Bs)	see *Phasgocale*
		Wrangun (Hi)	*Tapoatafa*

* This is a widespread word in Victoria languages for *Phascogale tapoatafa*. *Wernda* is given for this species but probably confusion as also recorded as name of one of the large gliders.

Potorous spp.	Kangaroo Rat (Bs,D,H,M)	Bri (H,M)	bri
Potoroos		Bree (Bs)	
		Winnenerbree (D)	winina-bri
Macropus giganteus	Kangaroo (A,Br,Bs,Bu,C,D,	Dhera (A)	djira
Eastern Grey Kangaroo	H,Hii,Ha,Ho,Hs,Ht,M,T)	Djira (Hii)	
		Jirra, Jirrah (Br,Bu,Bs)	
		Jirra (Ht)	
		Girra (C)	

(Presumed) Scientific Name	Common names used in original	Anglicised Aboriginal word used in original	Tentative phonetic rendering in practical orthography
		Jerra, Dirra, Deera, Jirrah (D) Jirah (H) Djeerah (Ho) Dyira (M) Tyirra (Hs) Jir-rah (S) Dhira (Ma) Tir-rer (T) Boulung-deera (Ht) Brangolo jirrah, Booyangan jirrah (Bs) Koorang (Ha)	kurang*

* This word belongs to Dauhurtwurru language of the Portland area of south-western Victoria.

M. rufogriseus Red-necked Wallaby	Red Wallaby (Bs,H,Hii)	Baoot (Ho) Kniara (H) Kinarra (Bs) Ginnera (Hii)	kinara
Wallabia bicolor Black Wallaby	Black Wallaby (Bs,H,Hii) Bk. Wallaby (Hi)	Therogang, Thakiran (H) Tharogang (Bs) Dakwun (Hi) Takwun (Hii)	tharagang thakwan (see *P. penicillata*)
Thylogale billardierii Red-bellied Pademelon	Wallaby (D) Paddymelon Wallaby (Bs) Paddymelon (H) Small Scrub Wallaby (Hi)	Bowie (D) Bowey (Bs) Baui (H,Hi)	*bowi*
Petrogale penicillata Brush-tailed Rock Wallaby	Rock wallaby (H,M) [?] Long-tailed wallaby (D) Kind of wallaby (Ht)	Dhagwan (M) Waiat (H) Talla-bowie, Tu-loo bowie (D) Tullow-bowie (Ht)	thakwan wayat tala-bowi, *tala* 'little' i.e. little wallaby
Pteropus poliocephalus Grey-headed Fruit-Bat	Flying Fox (H,M)	Blam-bang (H) Ngaian (M)	blembang ngayan
Conilurus albipes White-footed Rabbit-Rat	Rabbit Rat (H,Hi)	not given (H) Jaiung (Hi)	
Rattus fuscipes Bush Rat	Common Rat (Bs,H) Bush Rat (Hi)	Biak (Bs) Baiuk (H,Hi)	bayak
Hydromys chrysogaster Australian Water-Rat	Water Rat (Bs,H,M)	Toorablang (Bs) Turblang (H) Durblang (M)	toorblang
Canis familiaris Tame or Feral Dog	Dog (A,Bs,D.H.M.) Tame Dog (Bu,C,Ho,Ha) Natives dog (Hii)	Ban (H,M) Bawn (A) Baan (Bu,Bs,Ha) Barn (Hii,Ho), Bonno (D) Baain (C)	baan
Dingo	Native Dog (Ma)	Ngurain (Ma), Ngooran (Bu)	ngooran
	Wild Dog (Bu,C,Mo)	Merricun (Ho), Merrigang (Bu) Merigang (C)	mirigaan
Equus caballus Horse	Horse (A)	Condo condo (A)	
Bos taurus European Cattle	Cattle (A) Bullock (D)	Bullaella (A) Bodagga (D)	bulela, budaka [from English "bullock"]

(Presumed) Scientific Name	Common names used in original	Anglicised Aboriginal word used in original	Tentative phonetic rendering in practical orthography
Pinnipedia	Seal (Bs,H,Hii)	Bithowi (Bs) Bilthaui (Bs) Gurnun (Hii)	 bilthowi
Cetacea	Whale (Bs,H,Hii)	Ba waiy (H) Baawang (Bs) Gandu (Hii)	baawayi

Birds

(Presumed) Scientific Name	Common names used in original	Anglicised Aboriginal word used in original	Tentative phonetic rendering in practical orthography
Aves	Bird (Bs,Br,Hs,T)	Tuin (Br,Bs) Ngalloong (Hs) Klart (T) Tarlo-jaak (Br)	 ngulung (see *Gymnorhina tibicen*) *miridjon*
Dromaius novaehollandiae Emu	Emu (A,Bu,Bs,C,D,H,Ha,Ho, M,Ma,)	Mi-owero, Miowera (Bu,Bs) Myowr, Crewee (Ho) miaor (A) Myour, Mioure (D) Maioor, Grewi (C) Maiaura (H,M) Maiyor (Ma) Myory (Ha)	mayoor
Eudyptula minor Fairy Penguin	Penguin (Bs)	Tarlo birndang (Bs)	*tala* birndang
Puffinus tenuirostris Short-tailed Shearwater	Muttonbird (Bs)	Bralak (Bs)	bralak
Pelicanus conspicillatus Australian Pelican	Pelican (A,Bu,Bs,C, D,H,Hii,Ho,Ht,M,Ma)	Booran (D,Bs,Bu) Boorang (Ha) Poorun, wodjil (Ho) Boorun (C) Bhurau, Kidill (Bs) Buran (H,Hii,M,Ma) Bhuran widill (A) Gwannung-bourn (Ht) Guanumburn, Gwanning-bourn (D)	booran
Anhinga melanogaster Darter	Darter or Serpent-bird (Bs)	Tharwan (Bs)	tharwan
Phalacrocorax spp. Cormorants	Cormorant (Bs) Black diver with white breast (S)	Karney (Bs) Koorowera (Bs)	karni koorawira
Ardea novaehollandiae [?] White-faced Heron	Crane (Bs,H) Grey Crane (M) Blue Crane (Hii)	Karlo (Bs,H) Galu (M) Karlu (Hii)	 karlu
Egretta alba [?] Great Egret	White Crane (Bs)	Tirtgerawan (Bs)	
Nycticorax caledonicus [?] Rufous Night Heron	Night Swamp bird (D)	Gaw-woo (D)	
Threskiornis spp. Ibises	Ibis (M)	Giwert giwert (M)	djiwert-djiwert
Platalea spp. Spoonbills	Spoonbill (H)	Waunig (H)	wayinik
Anseranas semipalmata [?]	Geese (Bs,H)	Nath (Bs,H)	naath

(Presumed) Scientific Name	Common names used in original	Anglicised Aboriginal word used in original	Tentative phonetic rendering in practical orthography
Magpie Goose *Cygnus atratus* Black Swan	Swan (Bu,BS,C,D), H,Ho,M,Ma,)	Kooindrook (C)	
		Kitai (Ma)	
		Babbine (Bs)	
		Gidi (Bu,Bs)	*gidayi*
		Gidai (H)	
		Giddai (M)	
		Giddi, babbiyung (Ho)	
	Swan (moulting) (D)	Guldi, Giddi (D)	
		Goonigour, Goonure (D)	goonigoor
Tadorna tadornoides Australian Shelduck	Mountain duck (Bs,H)	Kar-quark (H) Kara-gnark (Bs)	karangark
Anas superciliosa Pacific Black Duck	Black Duck (Bu,Bs,C, H,Ha,Ho,M) Duck (A)	Wiranga (A)	warang
		Wreng (Bu,H)	
		Wrang (Bu,Bs,C,M,Ma, in H but deleted as in error)	
		wirrung (C)	
		woorang (Ha)	
		Oowreng, Nurdurt (Ho)	nardat
Anas spp. Ducks	Teal (H) Teal Duck (Bs)	natath (H,Bs)	(see *Anas superciliosa*)
	Wild Teal (A)	Darauck (A)	
	Duck (D)	Boodjan (D)	*budjan**

* Recorded by L.A.H. as general term for bird in Southern Ngarigo (Delegate area).

Anas rhynchotis Australasian Shoveller	Spoolbill duck (D) Spoonbill duck (Bs) Spoonbilled duck (Hs)	Wy-yang (D) Wyung (Bs) Wahyang (Hs)	wayan
Malacorhynchus membranaceus/ *Aythya australis* Pink-eared Duck/Hardhead	Widgeon (Bs,H)	Kurtgan (H), Koortgan (Bs)	kurdgan
Chenonetta jubata Maned Duck	Wood Duck (Bu,Bs,C H,Ha,Ho,Ma)	Nembalagang (Bu) Jellangoong (Bu) Jeelungeetic (Ho)	
		Naidit (C)	nardat (See *Anas superciliosa*)
		Yellan nandik (Bs,H)	djilanandik
		Woorangy (Ha)	warang (see *Anas superciliosa*)
		Nark (Ho) Naak (Ma)	naak
Biziura lobata Musk Duck	Musk Duck (Bs,H)	Tuk (H)	tak
		Ban (Bs)	ban
Pandion haialetus/ *Haliaeetus leucogaster* Osprey/White-bellied Sea-eagle	Fish Hawk (Bs) -? Hawk (Hii)	Be win, Birn (Bs) Biwing (Hii)	biwin
Elanus notatus [?] Black-shouldered Kite	Small Grey Hawk (Bs)	Troon wagga (Bs)	
Accipiter novaehollandiae Grey Goshawk	White Hawk (Bs)	Boon boong (Bs)	bunbung
Aquila audax Wedge-tailed Eagle	Eagle Hawk (Bu,Bs, Hii,Ht,M,Ma)	Quarnamerong (Bu) Quarrnamaroo (Hs)	karnamarung

(Presumed) Scientific Name	Common names used in original	Anglicised Aboriginal word used in original	Tentative phonetic rendering in practical orthography
	Eagle (Br,Bs,Hs,T)	Gwannam-o-rook (Ht)	
		Kurnugmuroon (C)	
		Quornamero (Br)	
		Quarnameroo (Bu,Bs)	
		Gwannumurung (a)	
		(Ht,Hii)	
		Quarnamerung (Bs)	
		Kaunamurung (Ma)	
		Thuronack (Br)	
		Poen-rung (T)	
Falco cenchroides [?]	Little Yellow Hawk (D)	Dite-yulk (D)	titiyal
Australian Kestrel	Common hawk (M)	Deddyel (M)	
	Sparrow hawk (Bs)	Tootooth gwan (Bs)	
Corturnix spp.	Quail (Bs,H)	Tirobigwanning (H)	turabinganang
Quail		Ooro bi gnanang (Bs)	
Gallinula tenebrosa/	Water Hen (Bs,D,H)	Neerloong (Bs)	nirlang
Porphyrio porphyrio	"Place of plenty	Nirlung (H)	
Dusky Moorhen or	water hens" (Hs)	Nailung (Hs)	
Purple Swamphen		Nalbong (D)	nalbang
Grus rubicundus	Native Companion	Balwin (Bu)	
Brolga	(Bu,Bs,C,H,Ha,Ho,M	Karloo-turtkurawan (C)	
	Ma)	Kooragan (Bs,Bu)	kurakan
		Kooracan (Ha)	
		Gooreekun (Ho)	
		Kuragau (H)	
		Guragan (M)	
		Kurakan (Ma)	
Ardeotis australis	Wild Turkey (A,C)	Curackan (A)	kurakan (see *Grus*
Australian Bustard			*rubicundus*)
		Woorngil (C)	woorngil
Pluvialis squatarola [?]	Grey Plover (Bs)	Bungil bowrndang (Bs)	
Grey Plover			
Charadriidae [?]	Red-bill Plover (Bs)	Tarlarang (Bs)	
Charadriidae/	Plover (Bs,M)	Birran birran (M)	biran biran
Vanellus spp.		Berin-berin (Bs)	
Gallinago hardwickii [?]	Snipe (Bs)	Klik (Bs)	
Latham's Snipe			
Scolopacidae	Curlew (Bs)	Bra (Bs)	
	Sandpiper (Bs)	Kewet-kewet (Bs)	
Larus novaehollandiae	Seagull (A,Bs)	Carouar (A)	
Silver Gull		Blithbrung (Bs)	blithbrang
Laridae/*Sterna* spp. [?]	Small White	Tarook,	taruk
	seagull	Tarlo wyak (Bs)	*tala* (little)
	Small Seagull (Bs)		wayak
Phaps spp.	Bronzewing (Bs,H)	Jubbuk (H)	djabak
Bronzewings		Tappak (Bs)	
Leucosarcia melanoleuca	Wonga (H)	Waukwakan (H)	wakwakan
Wonga Pigeon	Wonga-wonga	Waakquagan (Bs)	
	Pigeons (Bs)		
	Wonga pigeon (M)	Dhabbak (M)	djabak (see *Phaps* spp.)
Calyptorhynchus spp.	Black Cockatoo	Ngeuuk (H)	nganak
Black Cockatoos	(A,Bs,H,M,Ma)	Nganak (Bs,M)	
		Nenack (A)	
		Ngirnak (Ma)	
Callocephalon fimbriatum	Gang Gang (H,Ht),	Keren (H)	karan
Gang-gang Cockatoo	Grey Cockatoo (Bs)	Karan (Bs)	
		Gner-ing (Ht)	

(Presumed) Scientific Name	Common names used in original	Anglicised Aboriginal word used in original	Tentative phonetic rendering in practical orthography
Cacatua galerita Sulphur-crested Cockatoo	White Cockatoo (A,Bu,Bs,C,H,Ha,Ho, M,Ma)	Brak (Bs) Brayak (Ho) Braak (Ha,Bu,Ma) Braek (C) Braite (A) Break (M) Bre-ck (M) Ngullukgoorung (Ho)	breyak
Platycercus elegans Crimson Rosella	Blue Mountain Parrot (Bs,M)	Wattat (Bs) Wataty (M)	watadj
Neophema spp.	Grass Parrot (Bs)	Toon (Bs)	
Psittacidae	Parrots (A)	Purhill (A)	paril (?)
Ninox novaeseelandiae Southern Boobook	Mo Poke (A,Br,Bs,D, Hii,Hs,M,T)	Uu-loch (A) Wookook Wokuk (Br,Bs) Wook-gook, Wookoock (Hs) Woo-cook (D) Woor-quok (T) Wakkung (M) Barndagrin (Hii)	*wook-wook*
Tyto spp. [?]	Little Brown Owl (HT)	Abin (Br) Ebing (a) (Ht)	ngabin
Apodiae [?]	Swift (D)	Cowwungan (D)	kowangan
Dacelo novaeguineae Laughing Kookaburra	Laughing jackass (A,Bu,Bs,C,Ha,Ht, M,Ma) Large King fisher (Bs)	Wookwook (Ha) Coarg (Ho) Kuak(Ma) Coack (A) Quak (Bs) Gwak (M) Kookokarrak (Bu) Burndigan (C) Kou-ark-mungee (Ht) Wokook (Bu)	(see *Ninox novaeseelandiae*) kowak (see *Ninox novaeseelandiae*)
Ceyx azurea [?] Azure Kingfisher	Small Kingfisher (Bs)	Thoormuryung (Bs)	thoormaryang
Halcyon sancta Sacred Kingfisher	Kingfisher with white neck (Bs)	Tanyankaragan (Bs)	tanyangaragan
Menura novaehollandiae Superb Lyrebird	Lyrebird (Bs,H) Pheasant (M)	Wurail (H) Wuraial (M) Woorail (Bs)	woorayil
Hirundinidae spp. [?]	Martin or Swift (Bs)	Koorngan (Bs)	koorngan
Hirundo neoxena [?] Welcome Swallow	Swallow (Bs,D)	Kilugan (Bs) *Gheet-wile (D)	*gert-wile**

* Not a Gippsland word: from N.W. Victoria (L.A.H.).

Petroica spp.	Robin Redbreast (Bs,H)	Tur-bring (H) Bululwrang (Bs)	tubring
Muscicapidae	Flycatcher (D)	Gweed-gun (D)	guwid-gun
Maluridae/ Acanthizidae	Wren (H)	Ngarugal (H)	ngarukal [see also *Corvus* spp.]
Acanthizidae	Small bird like tomtit (Bs)	Ya rang (Bs)	yarang

(Presumed) Scientific Name	Common names used in original	Anglicised Aboriginal word used in original	Tentative phonetic rendering in practical orthography
Manorina melanophrys Bell Miner	Little Bellbird (D) Bellbird (Hii)	Chu-lurn (D) Gwenet (Hii)	
Dicaeum hirundinaceum Mistletoebird	Mistletoe bird (Bs)	Chirtgang (Bs)	
Emblema spp. [?] Firetail Finches	Small bird with patch of red over tail (Bs)	Bribatith (Bs)	
Ptilonorhynchus violaceus Satin Bowerbird	Satin-bird (Bs)	Bungil warndowan (Bs)	
Grallina cyanoleuca Australian Magpie-Lark	Pee-wee (M)	Nanawan (M)	nanawang (M)
Cracticidae	Crow-shrike (Bs)	Wooryung (Bs)	woorang/ warang [see *Strepera* spp.]
Gymnorhina tibicen Australian Magpie	Magpie (Bs) Common magpie (M) White magpie (A) Crow (C)	Clart (A) Glart (M) Klart (Bs) Klard (C)	klard
Strepera spp. [?] Currawongs	Black magpie (A)	Wreong (A)	warang
Corvus spp. Ravens	Crow (Br,Bs,Bu,C,H, Hii,Ha,Ho,Hs,M,Ma,T)	Wa-gara (Br) Woggara (Bu)	wokara*

* This word is widespread in Australia it has been recorded by Mathews for Thoorga on the south coast of NSW.

		Waageri (C) Wagara (Bu) Waygara (Bs) Wong (Ha)	
		Narrokul (Ho) Nar-ru-quon (T) Ngarroogall Ngarugal (H,Hii) Ngarukal (M) Ngaroogal, Gnar-o-kal (Bs) Gnuro-jal (Br) Ngarukol (Ma) Eumummurut (Ho)	ngarukal
	Egg (Br,Bs,D,H)	Bonieyong, Boneyong (D) Boyang (Bs) Boyang (Br) Booyang (Hs) Tha, Thuja (Br)	*buyang*

Reptiles

Serpentes	Snake (A,Br,Bu,C, Ho,Ha,Hs,Ma,T)	Toorung (C) Thurrung (Br) Thoorung (Bu) Thurung (Ho) Too-roo (T)	*thurung* (see *Notechis scutatus*)

(Presumed) Scientific Name	Common names used in original	Anglicised Aboriginal word used in original	Tentative phonetic rendering in practical orthography
		Dharenga (A) Thuroong (D) Toorroong (Hs) Galelung (Ho) Laue-beri (H) Kalang (Br,Bu) Koran (Ha) Coorootmill (Ha)*	lowaberi (see *Morelia spilotes*)

* A word from western Victoria, see *gurnwil, gurnmill* Hercus (1969).

Australaps sp. [?]	Small Snake (Bs) A yellow Snake (Ht) * Leatherhead (Hii)	Koon gwan (Bs) Nigga-the-rook (Ht) Tatau-o-luk (Hii)	

* appears in list of three other snakes, subsequently with birds and frogs, may refer to *Coracina novaehollandiae* or *Philemon corniculatus*.

Psuedechis porphyriacus Red-bellied Black-Snake	Red belly black Snake (H) Black Snake (Bs,H, Hii,M)	Tunyaruk (H) Duinyerrak (M) Toonyarak (Bs)	toonyarak
Notechis scutatus Tiger Snake	Tiger Snake (H,Hii) Red Snake or Brown (Bs)	Thurung (H) Thurung (Bs) Jilung Naiabun (Hii)	*thurung* (see *Pseudonaja textilis*)
Pseudonaja textilis Common Brown-Snake	Brown Snake (H,Hii,M)	Dhurung (M) Thurung (Hii) Ngaz-abun (H)	*thurung* (see *Notechis scutatus*)
Morelia spilotes [?] Diamond Python	Wood (Snake) or constrictor snake (Bs) Pretty coloured Snake (Hii) Carpet snake (M)	Loowa birri (Bs) lauaberi (Hii) Laualbirr (M)	lowaberi
Scincidae	Lizard (A,H) Small lizard (Bs,M)	Carar dong (A) Keratung (H) Keratung (Bs) Balmbung (M)	*kiratang*
Varanus varius[?] Lace Monitor	Iguana (Bs,H,Hii,Ma) Tree Iguana (M) Dead Gohanna (D) Goanna (A)	Bathaluk (H) Badhalok (Ma) Bathalook (Bs) Bataluk (Hii) Buddhaluk (M) Dirdide bodullock (D) Goon gwan (A)	*budalak* *derdigan* (dead) *budalak*
	[?] Dew Lizard (H)	Gun gun (H)	goongun
Sphemorphus spp. [?]	[?] Sleepy lizard (M) [?] Water lizard (M)	Gungwan (M) Tharawurt (M)	
Chelodina longicollis Long-necked Tortoise	Tortoise (D) [?] Turtle (M,Hii)	Nart (D) Ngeth (M) Ngat (Hii)	ngaath

(Presumed) Scientific Name	Common names used in original	Anglicised Aboriginal word used in original	Tentative phonetic rendering in practical orthography
	Amphibians		
Salientia spp. Frogs	Frog (Bs,H,Hii,M)	Jiddeluh (H) Tedalek (Hii) Tirtalack (Bs) Dirdillak (M)	thatilak
Litoria aurea/L. raniformis	Bell Frog (A)	Dhe dillock (A)	
Limnodynastes spp. *(dumerili* ?)	Bull Frog (H)	Bluk (H)	blook

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Appendix 1

Notes on the tentative phonetic rendering aid in practical orthography (L.A.H.)

Symbol	*Approximate pronunciation*
Vowels	
a	as in 'father'
aa	as a very long form of the 'a' in father
ow	as in 'cow' (this is the dipthong[au] in phonetic script)
u	as in 'put'
oo	as in 'goose'
e	as in 'bed'
ayi	as 'y' in 'by' (this is the dipthong [ai] in phonetic script)
i	as in 'bid'
Consonants	
ng	as 'ng' in English 'sing'
dj	as 'j' in jewel'
th	as in 'thorn'
rl rd rn	These are retroflex consonants, pronounced with the tip of the tongue curled backwards. They are not found in standard English, but rl, rd and rn are the closest equivalents, something approaching the consonant 'rd' is the pronunciation of 'rt' in American English e.g. in 'Martin'.
nj	palatal n, similar but not identical with 'ny' in English 'canyon'.

Voiced and unvoiced plosive consonants are not distinguished from one another, thus there is no distinction of any significance between d and t, b and p, g and k.

However in some positions the plosive consonant may sound more like a 'k', in others more like a 'g'. This has been recognized in formulation in order to give a pronunciation as close as possible to the original.

The accent *always* falls on the first syllable of a word. (There are a few notes on phonetics of Gippsland vocabulary in Hercus (1969).)